PORT NO. UMTA-MA-06-0025-79-8

NOISE ASSESSMENT OF THE CHICAGO TRANSIT AUTHORITY RAIL RAPID TRANSIT SYSTEM

Marshall L. Silver
Robert C. Bachus
Roland Priemer

University of Illinois at Chicago Circle
Box 4348
Chicago IL 60680

JANUARY 1979

FINAL REPORT

DOCUMENT IS AVAILABLE TO THE PUBLIC
THROUGH THE NATIONAL TECHNICAL
INFORMATION SERVICE, SPRINGFIELD,
VIRGINIA 22161

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
URBAN MASS TRANSPORTATION ADMINISTRATION
Research and Education Division
Washington DC 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No. UMTA-MA-06-0025-79-8	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle: Noise Assessment of the Chicago Transit Authority Rail Rapid Transit System		5. Report Date: January 1979
		6. Performing Organization Code
7. Author(s): Silver, M.L., Bachus, R.C., and Priemer, R.		8. Performing Organization Report No.: DOT-TSC-UMTA-78-52
9. Performing Organization Name and Address: University of Illinois at Chicago ~~Circle~~*, Box 4348, Chicago, Illinois 60680		10. Work Unit No. (TRAIS): R9743/UM949
		11. Contract or Grant No.: US-DOT-IL-0007
12. Sponsoring Agency Name and Address: U.S. Department of Transportation, Urban Mass Transportation Administration, Research & Education Division, Washington, D.C. 20590		13. Type of Report and Period Covered: Final Report, October 1974 - July 1975
		14. Sponsoring Agency Code: UTD-30

15. Supplementary Notes

*Technical Direction by: U.S. Department of Transportation, Research and Special Programs Administration, Transportation Systems Center, Cambridge Massachusetts 02142

16. Abstract

This report describes the noise on and near the Chicago Transit Authority (CTA) urban rail transit lines. It is one of a series of coordinated assessments sponsored by the Urban Mass Transportation Administration under the technical administration of the Transportation Systems Center of the U.S. Department of Transportation.

The CTA urban rail lines consist of approximately 86 miles of two-way revenue track (of which 9.6 miles are in subway) and 155 stations.

Noise data are given for specific measurements made in cars, in stations, and along the non-subway wayside at selected locations. Based on these measurements, in-car average maximum A-weighted sound levels, L_A(Max), which range from 65-100 dBA, are estimated to be in the 80 to 90 dBA interval for 61 percent of the CTA system route mileage (for the noisiest car type operated on each route). Wayside L_A(Max) levels at the nearest impacted structure range from 72 to 106 dBA, and exceed 100 dBA for 56 percent of the above ground route mileage. Station L_A(Max) levels range from 75 to 105 dBA, and are estimated to be in the 80 to 89 dBA interval for 75 percent of the CTA stations.

The rationale for choice of measurement sites and the methodology for arriving at the summary noise distributions from the data is discussed explicitly. Measurement and analysis instrumentation and procedures are also described.

17. Key Words: noise, transportation noise, measurement of noise, noise control rail noise, rapid transit noise	18. Distribution Statement: DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	312	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

This report has been prepared under the sponsorship of the Urban Mass Transportation Administration's (UMTA's) University Research and Training Division. The work was performed under the technical direction of the U.S. Department of Transportation's Transportation Systems Center (TSC), which manages the Urban Rail Noise Abatement Program for UMTA's Office of Technology Development and Deployment. The objectives of this program are to assess noise produced by urban rail transit operations and to appraise methods and costs for noise reduction.

This report is one in a series of six noise assessment reports covering noise due to transit operations on seven rail transit systems in five U.S. cities. Consistent results of the six assessments were achieved through use of standardized noise measurement and data reduction procedures developed at TSC and tested on the Massachusetts Bay Transportation Authority (MBTA) in Boston. The assessment report for the MBTA was published in 1974.*

Physical differences among the transit systems, as well as differences in the technical orientations of the teams and in funds available to the teams for measurement and analysis, led to some differences in report organization, technical depth, and writing style. Therefore, to provide at least introductory consistency among the reports for the reader, the front material, including the introduction of each assessment report, has been edited at TSC. The organization and technical content of each report, however, are basically as originally written by the respective teams and are, together with the accuracy of the measurements, the responsibility of the authors: Marshall L. Silver, Robert C. Bachus, and Roland Priemer. Dr. Leonard Kurzweil of the Transportation Systems Center directed the final technical editing of the report.

Acknowledgement is gratefully made to the Chicago Transit Authority for their support and cooperation in this noise assessment. In particular the help of Mr. A. Sandburg, Mr. A. Kalogeras, and Mr. R. Smith of the Division of Engineering was indispensable in performing this study.

Recognition is also given to Mr. S. Parkizgar and Mr. O. Cifuentes for their assistance in the field and in the laboratory.

---

*L.G. Kurzweil, R. Lotz, and E.G. Apgar, "Noise Assessment and Abatement in Rapid Transit Systems," UMTA-MA-06-0025-74-8, Sept. 1974.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

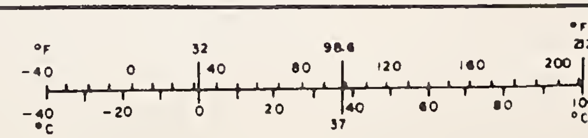


TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF FIGURES

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

LIST OF TABLES

LIST OF TABLES (Cont.)

LIST OF DEFINITIONS

L_A(Max) - Maximum A-weighted sound pressure level for a given noise event, measured in dBA.

L_R - The time-weighted sound pressure level, defined as:

$L_R = L_A(\text{Max}) + 10 \log T_5$ (in dBA)

L_R is an approximation of the single event noise exposure level (SENEL).

T_5 - Duration between the 5 dBA-down-from-L_A(Max) points, measured in seconds.

L_{eq} - Equivalent sound level, in dBA; represents that constant level which for a given period of time would contain the same amount of sound energy as the time-varying sound for the same period. Approximated by:

$$L_{eq} = L_R - 10 \log T$$

T - Duration of a noise event, in seconds.

SUMMARY

The Urban Mass Transportation Administration is supporting a program under the technical administration of the Transportation Systems Center to determine the noise climate of the major rapid rail transit systems of the United States, and to assess the impact of that noise on patrons, employees, and wayside communities. The results are to be used in determining the approaches and associated costs required to reach various selected noise abatement levels. The methodology, measurement techniques, and analysis are common for all systems studied so that results can be compared. Noise assessment reports, covering each of the major rapid transit systems, are being issued as a series.

CTA System Description

The Chicago Transit Authority (CTA) operates on six major rapid rail routes serving all sections of the City of Chicago and several Cook County suburbs. In addition, a loop shuttle serves the Chicago central business district. The total system route length is approximately 86 miles, with 11 percent underground, 43 percent on elevated steel, and 46 percent on either at-grade, open-cut, or elevated embankment track. The roadbed is primarily bolted rail on wood ties (64 percent), but welded rail on wood ties (22 percent) and welded rail on concrete ties (14 percent) are also employed.

The CTA rapid rail system consists of 155 stations, 48 percent of which are situated on elevated steel structures.

The most common station configuration is the center platform (50 percent), with the side platform configuration (44 percent) also heavily represented.

At the time noise measurements were taken, the CTA urban rail transit fleet consisted of approximately 1100 rail vehicles of five distinct types. About 70 percent of these vehicles (most of which are 6000 series cars constructed in the 1950's) have no acoustical treatment. The newer 2000 and 2200 series cars, comprising 30 percent of the fleet, are equipped with air conditioning and have sealed windows. A new vehicle type, the 2400 series car, was introduced in 1976, after the noise measurements were compiled. These vehicles have better acoustical design features than the older cars.

Noise Measurement Procedures

Noise assessment was of three general types:

1. In-car noise
2. In-station noise
3. Wayside noise.

Signals were recorded on a three-channel tape recorder, using two channels for the noise data and a third channel for voice commentary. In order to insure a data format which would be compatible with that of the other investigators involved in the UMTA urban rail noise assessment program, a carefully calibrated graphic level recorder was used for noise measurement display.

The physical, climatic, and environmental factors associated with each set of noise measurements were recorded, as well as the type and number of cars in the train. Train speed was recorded during each of the noise measurements using a portable radar unit.

In-car noise level measurements were made for cars traveling on all CTA routes. Time and effort constraints, however, prohibited a complete survey of stations and wayside communities. Instead, a sample of noise measurements was taken at representative sites, which were selected based on those physical characteristics most strongly related to rail noise levels. Selection of sample sites was facilitated by accessing a computerized noise data management system. This system maintains a data base of system-wide information regarding noise levels, as well as ten attributes relating to physical characteristics of the system (e.g., track structure, track geometry, etc.).

Detailed results of the measurement program are too extensive to be shown in this summary. However, the following estimates, in dBA, were determined for the entire CTA system (Table S.1):

TABLE S.1 AVERAGE MAXIMUM A-WEIGHTED SOUND LEVEL DISTRIBUTION OF THE CTA SYSTEM

	MAXIMUM SOUND LEVELS (dBA)									
	60-65	65-69	70-74	75-79	80-84	85-89	90-94	95-99	100-104	105-110
Car Interior (Percent of Route Mileage)*	0.1	2.1	4.2	21.8	36.1	24.8	9.1	1.8	-	-
Wayside, at Nearest Impacted Structure (Percent of Above Ground Route Mileage)	-	-	0.6	12.0	28.5	4.0	8.6	-	14.0	32.3
Station Platform (Percent of Stations)	-	-		13.8	20.4	54.6	0	10.5	0.7	-

*Data are for the noisiest car type on each route.

1. INTRODUCTION

1.1 PROGRAM SCOPE

This report describes the noise climate of the Chicago Transit Authority (CTA) urban rail transit system. Other contractors have undertaken similar assessments of urban rail lines operated by the Bay Area Rapid Transit District (BART), the Southeastern Pennsylvania Transportation Authority (SEPTA), the Port Authority Transit Corporation (PATCO), the Greater Cleveland Regional Transit Authority (RTA), formerly the Cleveland Transit System (CTS), and the New York City Transit Authority (NYCTA), including the Staten Island Rapid Transit Operating Authority (SIRTOA) and the Port Authority Trans-Hudson (PATH). These noise assessments are reported in other documents of this series.

This work was done as part of an Urban Mass Transportation Administration (UMTA) program to assess the noise produced by various U.S. urban rail transit operations and to appraise methods and costs for reduction of such noise. The characterization of the noise climate of each rail transit system, carried out in a uniform manner, provides data to assist in determining UMTA priorities and funding decisions. The noise assessment activity has three elements:

1. Noise climate assessment
2. Consideration of abatement technique options
3. Cost estimation for abatement to specified noise levels.

Specifically, this activity allows noise level comparisons (a) of systems, (b) of different types of equipment or track structures on the same system, and (c) before and after noise control actions. It also provides data pertinent to the establishment of possible regulatory action to control noise levels.

The specific purpose of the work reported in this volume is to measure and otherwise describe the noise climate of the CTA urban rail system, as well as to describe the measurement and analysis methodology used. This report also presents a physical inventory of system characteristics such as track structure type, vehicle type, station type, and other factors that influence generated and perceived system noise. This information has been assimilated into a readily accessible computerized data management system. The system links noise measurement data with physical characteristics of the system in order to develop a complete picture of the noise climate on the CTA urban rail lines.

In-car noise level measurements were made in cars traveling along all CTA routes. Time and effort constraints prohibited a complete survey of stations and wayside communities, however. Instead, sample noise measurements were taken at representative sites, which were selected based on those physical characteristics most strongly related to noise levels. This approach, common to all assessments, is based on the noise assessment of the Massachusetts Bay

Transportation Authority (MBTA),* which served as a pilot study for these later assessments. Consistency of results was achieved through the use of a standarized noise measurement and data reduction process. This process was successfully validated through "round robin" tests, in which the assessment teams made simultaneous measurements of noise from Massachusetts Bay Transportation Authority trains and, without communication between teams, reported the resulting reduced data. The findings of all teams were generally within 3 dBA of the average for any part particular measurement and, in most cases, within 1 dBA.

The present data describe the existing system noise climate and permit a first order estimate of abatement techniques and associated costs to satisfy reduced noise level criteria. When a preliminary investigation such as this reveals noise problems, and a decision is made to proceed with their solution, more detailed measurements and analyses must be made. Normally, this would include detailed diagnostic measurements to identify the dominant sources and paths for engineering design of site-specific noise control treatments.

---

*Kurzweil, et al., "Noise Assessment and Abatement in Rapid Transit Systems."

1.2 READER'S GUIDE TO REPORT

Section 1.3 of this report includes a general description of the rail rapid transit system in Chicago. After detailing route characteristics and track structure types, the chapter concludes with a brief history of the formation of the Chicago Transit Authority (CTA). Recent improvements to the system are also described.

Noise measurement and instrument calibration procedures are described in Chapter 2. The equipment used both in the field and in the laboratory is also described.

Chapter 3 presents the techniques used for compiling an inventory of the physical characteristics of the CTA system such as structure type, track type, track geometry, station configuration, type of wayside community, and other factors that influence generated and perceived system noise. A computer data management system, developed to correlate and access the physical characteristics and all the collected noise level data, is described in this chapter, and detailed in Appendix A.

The results of the measurement program for noise levels as perceived by in-car passengers, in-station transit patrons, and the wayside community are presented in Chapters 4, 5, and 6, respectively.

Chapter 4 describes the types of cars, their acoustical characteristics, and the strategy developed for in-car noise measurement. Examples are presented of a typical time history of in-car noise levels, as well as the in-car noise level

reporting format. Also included is a summary of in-car noise levels for the system. In Appendices B and C in-car noise level data and route descriptions are presented for each section of the CTA rail rapid transit system.

Chapter 5 begins by describing the physical characteristics of the 155 transit stations operated by the CTA. The procedure followed in selecting representative stations is then described. System summaries of station noise levels are presented; noise level data for individual sample stations are collected in Appendices, D, E, and F.

The locations chosen for wayside noise measurements, along with their physical characteristics and noise measurement procedures, are shown in Chapter 6. Sample time histories and summaries of wayside noise level data for the entire system are also presented. Appendix G includes detailed descriptions of all the wayside noise level data obtained.

1.3 THE CHICAGO TRANSIT AUTHORITY SYSTEM

1.3.1 General Description

The principal mass transportation carrier within the city of Chicago is the Chicago Transit Authority, which operates the second largest public transit system in North America. The CTA serves all sections of Chicago; ninety-nine percent of the city's population lives within 3/8 mile of CTA service. CTA also serves Cook County suburbs.

Service is provided on 131 bus routes, which cover about 1920 miles of city and suburban streets, and on six rapid transit routes, which cover approximately 86 miles of streets and right-of-ways. Over half these routes are serviced on a 24-hour-day, seven-day-week, 365-day-year basis. The system includes about 2400 motor buses and 1100 rapid transit cars.

On a typical weekday, the CTA provides about 2.1 million revenue rides. Some 325,000 passengers originate on the six rapid transit lines while another 950,000 originate on buses. Approximately 300,000 originating passengers purchase transfers which entitle them to one or more additional rides over connecting CTA bus or rapid transit routes.

1.3.2 Rail Rapid Transit Service

A schematic representation of the CTA rail rapid transit service routes is shown on Fig. 1.1 and the characteristics of each of the lines are summarized in Table 1.1. Descriptions of the service routes follow.

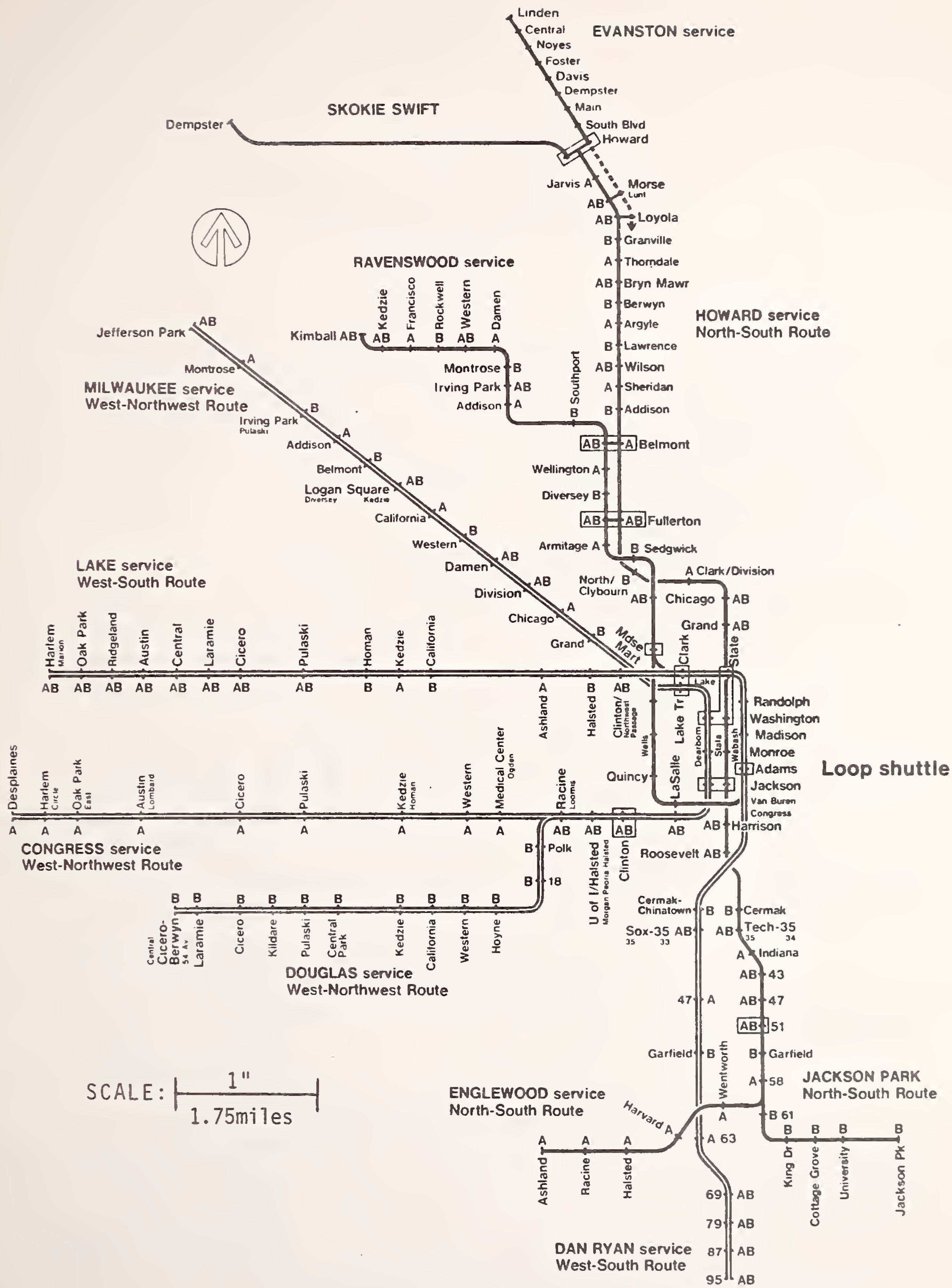


Fig. 1.1 Schematic for the CTA Rail Rapid Transit Lines and Stations

TABLE 1.1

SUMMARY OF ROUTE CHARACTERISTICS
RAIL RAPID TRANSIT LINES
CHICAGO TRANSIT AUTHORITY

NAME and LINE SECTION	LENGTH (miles-km.)		AGE	TYPICAL STRUCTURE
Englewood Service: Washington and State to Ashland and 63rd.	9.46	15.22	older >25yrs	Subway: Washington to 14th, Steel elevated structure: 14th to the end of the line.
Jackson Park Service: 58th and King Drive to 63rd and Stony Island Blvd.	2.00	3.22	older	Steel elevated structure.
Dan Ryan: Madison and Wabash to 95th and State Streets.	11.20	18.02	new <10yrs	Steel elevated structure: Madison to 18th, Concrete elevated: 18th to 28th, Median strip: 28th to the end of the line.
Congress Service: Washington and Dearborn to Des Plaines Avenue.	9.54	15.35	newer <25yrs	Subway: Washington to Halsted, Median strip: Halsted to Central, At-Grade: Central to the end of the line.
Douglas Service: Racine and Congress.	6.30	10.14	newer	Steel elevated structure: Racine to Kildare, At-Grade: Kildare to the end of the line.
Lake Service: Madison and Wabash to Lake and Harlem Streets.	8.93	14.37	older	Steel elevated structure: Madison to Laramie, Elevated embankment: Laramie to the end of the line.
Milwaukee Service Washington & Dearborn to the Jefferson Park Terminal.	9.16	14.74	new	Subway: Washington to Damen, Steel elevated structure: Damen to Kedzie, Subway: Kedzie to AddisonSt., Median Strip: Addison to the end of the line.

TABLE 1.1

(Continued)

NAME and LINE SECTION	LENGTH (miles-km.)		AGE	TYPICAL STRUCTURE
Ravenswood Service: Clark and Lake to Lawrence and Kimball Ave.	11.00	17.70	older	Steel elevated structure: Madison to Western and Wilson, At-Grade: Western to the end of the line.
Howard Service and Evanston Service: Washington and State to Linden street.	12.61 3.9	20.29	older	Subway: Washington to Armitage, Steel elevated structure: Armitage to Wilson, Elevated embankment: Wilson to Noyes, At-Grade: Noyes to the end of the line.
Skokie Service: Howard and Clark to Dempster and Bronx Street.	4.9	7.43	older	Cut-Grade: Howard to Pulaski, At-Grade: Pulaski to the end of the line.
TOTAL ROUTE DISTANCE:	85.98	143.22		

The Howard Service and the Evanston Service serve the North Side of Chicago and the suburbs of Evanston and Wilmette on elevated structures, embankment, and at-grade. The Ravenswood Service, on steel elevated structures and at-grade, serves the Northwest Side of Chicago, and the at-grade and elevated embankment Skokie Swift serves the northern suburbs of Skokie and Morton Grove.

The Dan Ryan Service, which travels down the median strip of the Dan Ryan Expressway, serves the south portion of the city. The Englewood and Jackson Park Service, on elevated steel structures, serve the southern portion of the city, with the Jackson Park Service branching east to Lake Michigan and the Englewood Service branching west.

The Lake Street Service travels due west on a steel elevated structure located directly over Lake Street and changes to elevated embankment west of Laramie. This line serves the western portion of Chicago and the suburbs of River Forest and Oak Park. The Congress Service proceeds down the median strip of the Congress Expressway, serving Chicago's West Side and the suburbs of Oak Park and Forest Park. The Douglas Park Service, on steel elevated and at-grade structures, branches from the Congress Service and serves Chicago's West Side and the suburbs of Cicero and Berwyn.

The Milwaukee Service travels northwest from the center of the city in subway, on elevated steel structures, and down the median of the Kennedy Expressway, serving the Northwest Side and the areas of Irving Park and Jefferson Park. The type of structure supporting the track on each of these routes is represented in Fig. 1.2.

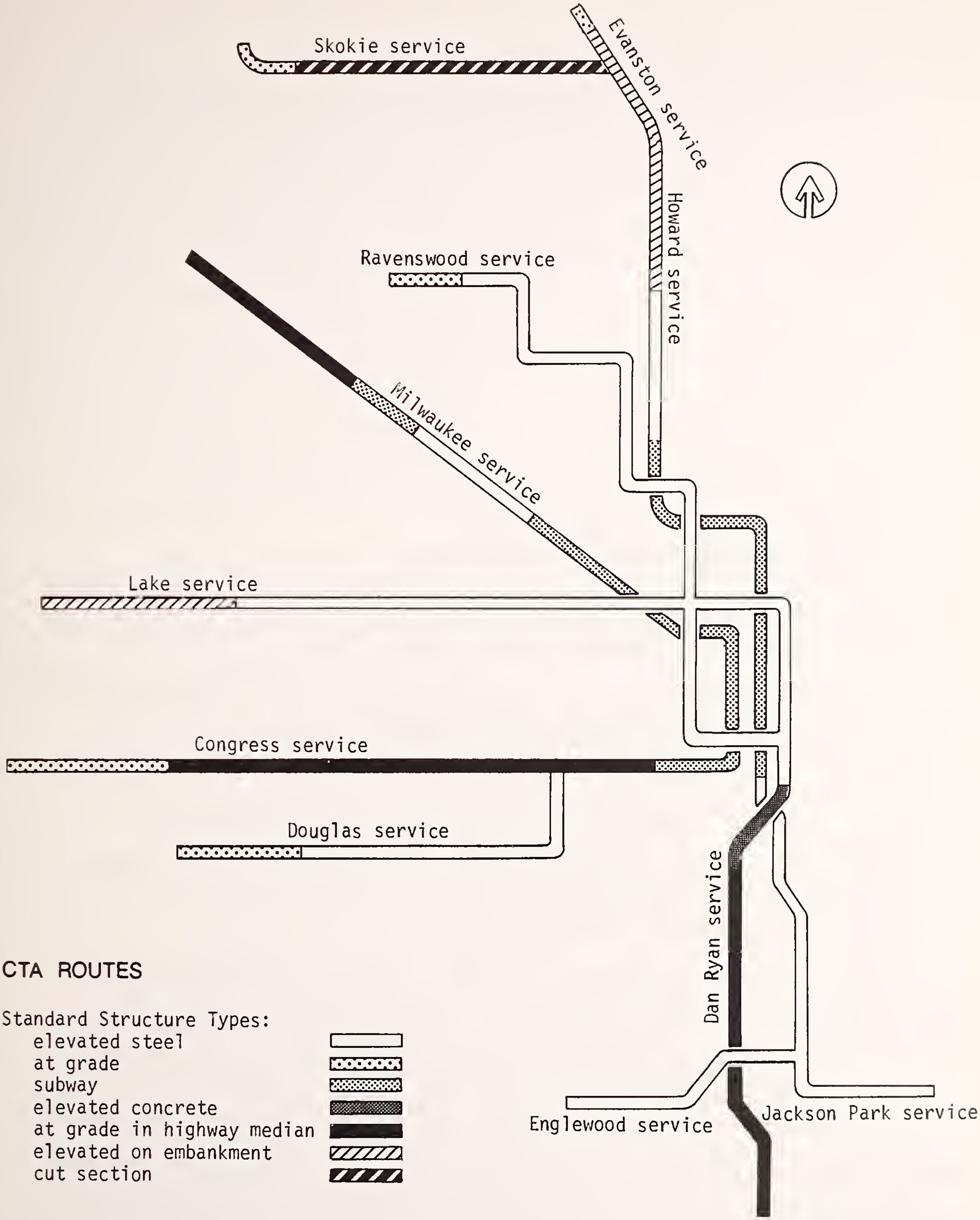


Fig. 1.2 Supporting Structures for the CTA Rapid Transit Lines

1.3.3 Transit Operation

Transit operation in many CTA stations is by an alternate train system. Stations are listed as "A stations," "B stations," or "AB stations," (Fig. 1.1) with alternate trains also designated as "A" or "B" trains. All trains stop in "AB stations," while only "A" trains stop in "A stations" and only "B" trains stop in "B stations," which allows alternate trains to travel non-stop through stations. However,train speed through stations is limited to 30 mph. At night, on holidays, and on some routes during non-rush periods, the alternate system is not used and all trains stop in all stations.

1.3.4 The Formation of the Authority

Surface transit service began in Chicago by privately-owned companies in 1859 with horse cars, while rapid transit began in 1892 with the introduction of steam trains on structures and rights-of-way that are still being used. However, there were always financial problems with these systems, partially due to public pressure both to maintain a very low fare structure and to provide economically unfeasible service in sparsely populated areas during periods of little travel.

The situation reached a critical stage in the late 1920's, when the two major Chicago transit companies, the Chicago Surface Lines and the Chicago Rapid Transit, became involved in receivership and bankruptcy proceedings. The failure of six separate and prolonged attempts to reorganize the two companies with the aid of private capital finally led to the establishment of a public authority with the ability to acquire, own, and operate the city's local transit facilities.

The Chicago Transit Authority, a self-regulating municipal corporation, separate and apart from all other federal, state, and local governmental agencies, was created by an act of the General Assembly of Illinois, approved April 12, 1945, and an ordinance adopted by local referendum of the city of Chicago April 23, 1945. The ordinance grants exclusive right to the CTA for operation of a comprehensive unified local transportation system in Chicago.

The Authority, as a corporate entity, has the power to acquire, construct, own, operate, and maintain for public service a transportation system in the metropolitan area of Cook County (except Barrington, Palatine, Wheeling, Hanover, Schaumburg, Elk Grove, and Lemont townships).

The governing and administrative agency of the Chicago Transit Authority is the Chicago Transit Board, consisting of seven members: four appointed by the mayor of Chicago, subject to approval of the City Council and the governor of Illinois, and three appointed by the governor, subject to approval by the State Senate and the mayor of Chicago.

CTA began local transit operations in 1947 by purchasing the properties of the former Chicago Surface Lines and the former Chicago Rapid Transit Company, and in 1952 purchased from the Chicago, Milwaukee, St. Paul and Pacific Railroad the right-of-way and facilities, from Montrose Avenue in Chicago to Linden Avenue in Wilmette, on which the rapid transit had operated under a lease arrangement. Purchase of all of these properties was financed by the sale of Chicago Transit Authority revenue bonds to private investors.

Extensive plant and equipment modernization has been accomplished by CTA from its own revenues. Expansion of system coverage (route miles) of the surface system to meet the needs of population growth within the city was accomplished largely by the release of equipment from existing routes due to reduced ridership. On the rapid transit system, where riding has remained essentially constant over a 20-year period, expansion to follow population growth could not be accomplished "from the fare-box," with the significant (but special) exception of Skokie Swift, which was aided by a federal grant.

The CTA is now a part of the Regional Transportation Authority (RTA) authorized by an act passed by the legislature in December, 1973, and approved in a referendum March 19, 1974. The Authority encompasses the six counties of Cook, DuPage, Kane, Lake, McHenry and Will. The Authority has the power to preserve and improve public transportation in the six county region through purchase of service agreements, grants to transportation agencies, or operation of the service. The Board of Directors is composed of four members appointed by the mayor of Chicago, two members appointed by the suburban Cook County Board, and two members appointed by the county Board Chairmen of the five outlying counties.

In planning, the Authority cooperates with the regional comprehensive planning bodies, submitting a five-year plan to the planning agencies for review and comment; this plan is updated yearly. Public hearings are held prior to the acquisition or construction of a facility of over $5 million and a major extension or addition to service.

Improvement of regional transportation is the aim of the Authority, and this is to be accomplished through the coordination of the various schedules and routes of the city and suburban systems, the integration of the various fare systems to provide for optimal ridership at fair rates, and the reimbursement to the CTA and private transportation companies for losses incurred.

1.4.5 Rail Rapid Transit Improvements

To improve Chicago's rapid transit facilities, public funds were invested in the State Street and Dearborn Street subways during the 1938-1951 period. The city of Chicago financed about 3/4 of the total cost while the federal government contributed the remainder from funds of the Public Works Administration. Construction of the West Side Subway, an extension of the Dearborn Subway, was paid for by the city of Chicago.

The West Side (Congress) Subway was the first transit project to combine rail rapid transit and a multi-lane expressway in the same, grade-separated right-of-way. Federal highway funds contributed importantly to financing the cost of the right-of-way for the combined facility. The city of Chicago, Cook County, and the state of Illinois financed and constructed various parts of the project, extending from the Chicago River to the Des Plaines Terminal in Forest Park, mostly in the median of the Eisenhower Expressway.

A cooperative effort between several governmental agencies resulted in the relocation of the western three miles of the Lake rapid transit line from street level onto the adjacent grade-separated

right-of-way of the Chicago & North Western Railway, eliminating twenty grade crossings.

The State, Dearborn, Congress and Lake projects markedly increased the efficiency of the service. They did not, however, significantly increase the service area of the system.

1.4.6 Chicago Involvement in Federal and State Transit Programs

Mass transportation demonstration grants from the federal government to underwrite the operating losses of test projects became an additional tool for improving transit in the 1960's. The Skokie Swift project was the first participation by the CTA in such a program. Later, when capital grant assistance of the federal government also became possible, Chicago voters authorized by referendum a general obligation bond issue to provide the local share for needed rapid transit extensions in Englewood and in the median strips of the Dan Ryan and Kennedy Expressways.

Mass transit grants took on a new dimension in Illinois during 1971 with the enactment of legislation funding part of the local share of federally-aided projects. The state is funding its share from a transportation general obligation bond issue, while motor fuel tax revenues were used to fund the Cook County and city shares. The state program was continued in TRA companion legislation.

State and federal programs have made it financially feasible to rebuild the transit system without relying solely upon operating revenues, so that the CTA has been able to begin a renewal and

Improvement of regional transportation is the aim of the Authority, and this is to be accomplished through the coordination of the various schedules and routes of the city and suburban systems, the integration of the various fare systems to provide for optimal ridership at fair rates, and the reimbursement to the CTA and private transportation companies for losses incurred.

1.4.5 Rail Rapid Transit Improvements

To improve Chicago's rapid transit facilities, public funds were invested in the State Street and Dearborn Street subways during the 1938-1951 period. The city of Chicago financed about 3/4 of the total cost while the federal government contributed the remainder from funds of the Public Works Administration. Construction of the West Side Subway, an extension of the Dearborn Subway, was paid for by the city of Chicago.

The West Side (Congress) Subway was the first transit project to combine rail rapid transit and a multi-lane expressway in the same, grade-separated right-of-way. Federal highway funds contributed importantly to financing the cost of the right-of-way for the combined facility. The city of Chicago, Cook County, and the state of Illinois financed and constructed various parts of the project, extending from the Chicago River to the Des Plaines Terminal in Forest Park, mostly in the median of the Eisenhower Expressway.

A cooperative effort between several governmental agencies resulted in the relocation of the western three miles of the Lake rapid transit line from street level onto the adjacent grade-separated

right-of-way of the Chicago & North Western Railway, eliminating twenty grade crossings.

The State, Dearborn, Congress and Lake projects markedly increased the efficiency of the service. They did not, however, significantly increase the service area of the system.

1.4.6 Chicago Involvement in Federal and State Transit Programs

Mass transportation demonstration grants from the federal government to underwrite the operating losses of test projects became an additional tool for improving transit in the 1960's. The Skokie Swift project was the first participation by the CTA in such a program. Later, when capital grant assistance of the federal government also became possible, Chicago voters authorized by referendum a general obligation bond issue to provide the local share for needed rapid transit extensions in Englewood and in the median strips of the Dan Ryan and Kennedy Expressways.

Mass transit grants took on a new dimension in Illinois during 1971 with the enactment of legislation funding part of the local share of federally-aided projects. The state is funding its share from a transportation general obligation bond issue, while motor fuel tax revenues were used to fund the Cook County and city shares. The state program was continued in TRA companion legislation.

State and federal programs have made it financially feasible to rebuild the transit system without relying solely upon operating revenues, so that the CTA has been able to begin a renewal and

replacement program for its system. The initial step of the development program began with the commitment of $140 million in 1972-73 for the procurement of 100 new rapid transit cars, and much track and structure renewal.

The current Phase II of the 1974 Capital Development Program will invest $391 million. These funds will be used to make additional improvements throughout the system, including the additional purchase of air-conditioned rapid transit cars, renewal of elevated structures and tracks, and renewal of some of the older rapid transit stations.

2. NOISE MEASUREMENT PROCEDURES

2.1 INTRODUCTION

In order to define the overall noise climate for the Chicago Transit Authority (CTA) rail rapid transit system it is convenient to divide the system into three zones, consisting of 1) an in-car measurement zone, 2) an in-station measurement zone, and 3) a wayside zone.

Noise measurements made in the in-car zone represent noise levels experienced by the rail rapid transit passenger. The rider is exposed to system-generated noises during the period of his journey; thus noise measurements to represent rider-perceived noise should be made continuously, so that both noise magnitude as well as duration can be evaluated.

In the in-station zone, noise levels perceived by the passenger waiting for rail rapid transit service may be made. In general, the noise exposure is short for the passenger waiting on the platform. However, depending on station acoustics, the noise level can be high, especially in older stations where acoustics were not originally considered in the design. Noise levels for a number of train arrivals and departures must be measured to develop a statistically valid measure of in-station noise.

Noise measurements made in the wayside zone may be used to represent noise levels transmitted to the community. Rail rapid transit noise along the wayside is intermittent, depending on the frequency of rail rapid transit service. As for in-station measurements, noise levels for a number of pass-bys

are required to develop a statistically valid measure of wayside noise.

By measuring noise in each of these zones, it is possible to represent the noise climate for all of the people who come in contact with rail rapid transit: the riding passenger, the waiting passenger, and the wayside community. Therefore, the results of the noise measurement program presented in subsequent chapters are based on these three classification zones.

2.2 MEASUREMENT EQUIPMENT

A measurement program such as the one undertaken requires easy movement of the measurement team through the rail rapid transit system and the ability to set up equipment without disrupting normal transit operations. Therefore, portable, lightweight, precision noise measurement equipment was selected for this program. A schematic representation of the equipment is shown on Fig. 2.1. All noise measurements were made using a precision sound level meter (SLM) with a microphone mounted on a tripod at least 1 meter (3.3 feet) from the sound level meter. Signals were recorded on a three channel tape recorder, with two channels for the noise data and a third channel for voice commentary, recorded through a special commentary microphone. Information such as microphone location, train position, and noise singularities was recorded on this third channel. The noise signal was then played back in the laboratory and recorded on the strip chart output of the graphic level recorder. At the same time, the commentary channel was monitored. The resulting noise time histories were analyzed to determine the magnitude and duration of the noise record.

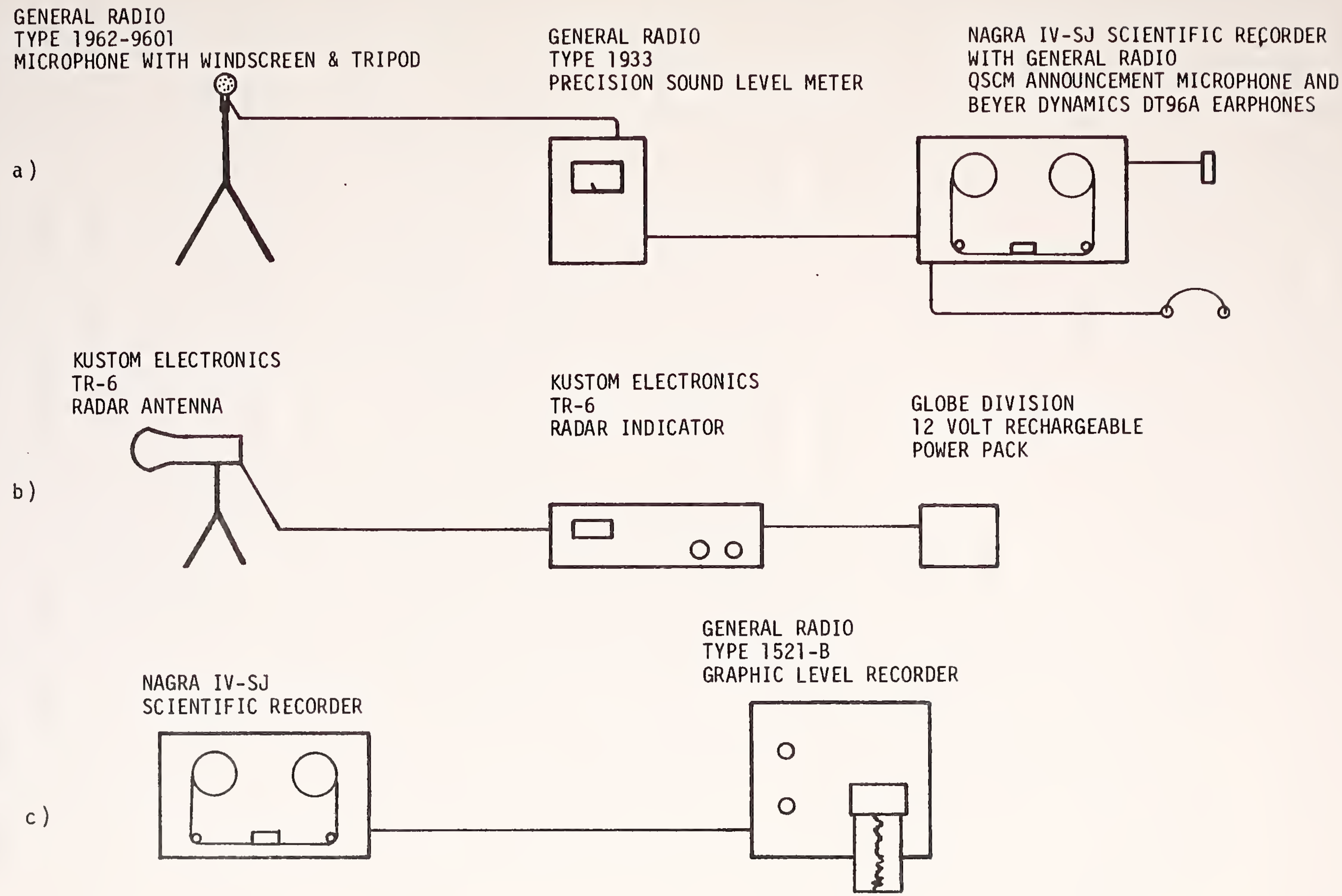


Fig. 2.1. Schematic Representation of a) Field Noise Measurement Equipment and b) Speed Measurement Equipment and c) Laboratory Data Analysis Equipment

Details of microphone placement and data analysis for each of the measurement zones is provided in subsequent chapters.

2.3 RECORDING AND PLAYBACK EQUIPMENT SETTINGS AND CALIBRATION

All measurements in the field were made using a linear scale for both the sound level meter and the tape recorder, with the sound level meter set on a "fast" recording setting. In the laboratory, the flat response recording was played back with the sound level meter set on A-weighted scale to produce the required A-weighted noise level time history from the graphic level recorder.

The standard calibration technique used consisted of recording a 1000 Hz - 114 dB signal on the tape recorder through the recording microphone. The 120 dB range setting and the flat response was used on the sound level meter and was recorded using the fast meter function on the tape recorder.

In order to insure compatible data format with other noise investigators involved in the UMTA urban rail noise abatement program, a graphic level recorder was used for noise measurement display. The recorder was calibrated using the following technique: 1) A 40 dB potentiometer was used for playback; 2) The lower limiting frequency was set at 20 Hz, which correlated to a writing speed of 10 in/sec; 3) Paper speeds were set at 2.5 in/min; 4) Pen damping was adjusted so that for a 1000 Hz tone burst the pen approaches the RMS value of the tone without overshoot or undershoot.

To insure that the resulting calibrated graphic level recorder was comparable to the processing equipment of other contractors, a test tape from the New York measurement group was obtained.

A time history record was made using our graphic level recorder and compared with a record from their recorder. It was found that our generated time histories agreed quite favorably with the New York record with respect to peak noise levels, duration of noise levels, and ambient noise levels. Thus, high confidence was achieved in the comparability of our data reduction equipment and that used by the New York group.

Careful calibration techniques were used and attention was given to noise measurement details to insure that high-quality, reproducible noise measurements were made. For example, the sound level meter was calibrated before and after each measurement series and earphones were used to monitor the noise levels to insure that proper noise levels were being recorded. Instruments such as the sound level meter, tape recorder, or tripod were never placed directly on a seat or floor of a moving vehicle but were isolated from vibrations with foam supports. Moreover, random noise measurements were noted from the sound level meter and were voice recorded on the tape for subsequent comparison with laboratory recordings to insure that no errors were being made on meter or tape recorder settings.

2.4 GENERAL MEASUREMENT PROCEDURES

Any ongoing noise measurement program that spans many months of data collection, such as the one undertaken, requires a systematic logging and control of climatic and environmental factors associated with the physical measurements. Only with knowledge of such variables is it possible to later develop an understanding of the factors that contribute to the magnitude and

sources of the noise levels recorded.

The physical, climatic, and environmental factors associated with each set of noise measurements made in each measurement zone are shown in Table 2.1. These factors include temperature, time of day, vehicle characteristics, and other factors. Every effort was made to control or minimize the effects of as many of these variables as possible.

For example, every effort was made to avoid any ambiguity caused by climatic conditions. Therefore, no measurements were made with snow on the ground since it is well known that snow influences noise propagation characteristics. In addition, no measurements were made during wet or rainy weather since it was found early in the program that measurements for wet rails are approximately 6 dBA quieter than measurements for dry rails.

In addition, great care was taken to record car type and the number of cars in the train for each noise measurement. Chicago uses a variable train length throughout the day, beginning with 2-car trains in the off-peak late night and early morning hours. Train length expands successively to 4-, 6-, and 8-car trains through the morning rush hour period. The number of cars is then successively decreased until 2-car trains are running at mid-day; the number of cars then increases again until the evening rush hour, when 8-car trains are again operating.

It was felt that the number of cars might influence recorded noise levels; therefore, for each noise measurement a record was made of the number of cars in each train as well as the car type.

TABLE 2.1

SITE PHYSICAL CHARACTERISTICS RECORDED FOR EACH NOISE MEASUREMENT

1. Date
2. Time
3. Temperature
4. Atmospheric pressure
5. Wind direction and speed
6. Relative humidity
7. Details of surrounding area
8. Car type and serial number
9. Number of passengers (in vehicle or on platform)
10. Car speed
11. Measurement equipment used
12. Equipment arrangement in relation to car, wayside, or station.

However, the operating agency, in order to insure safe operation, required that no in-car noise measurements be made during the peak rush hours. Therefore, most measurements were made between 10:00 a.m. and 3:00 p.m. with the result that the majority of the noise measurements are for 2-car trains.

For each of our noise measurements the speed of the train was recorded using a portable radar unit similar to that used for police speed checks. It was felt that accurate speed data was critical for subsequent record analysis, since other research on rail rapid transit noise has shown that noise increases with train speed both for in-car and wayside measurements. The radar unit, represented in Fig. 2.1, is accurate to ± 0.1 mph and was calibrated using an internal calibration procedure as well as external tuning fork at the beginning and end of each measurement sequence. The equipment was used to record the pass-by speed of trains traveling along the right-of-way or the pass-through speed in-stations. The train speed during in-car measurements was obtained by pointing the measurement antenna out through the window of the vehicle and sighting on passing buildings. Calibrations with this equipment performed from an automobile showed that measurements taken using this technique for measuring in-car speed approached the accuracy of the radar unit.

Each measurement location was carefully selected and described to insure that extraneous conditions such as noisy station equipment or noisy in-car equipment did not provide an

anomalous noise measurement situation unrepresentative of typical system conditions.

For this measurement program, it was necessary to assure that enough data was acquired to guarantee that a 5 dBA change in noise level will be significant at a 0.05 confidence level. Therefore, the following measurement frequencies were used as a guide in making noise measurement:

In-Car:	One Round Trip in Each Car Type on Each Line
In-Stations:	From 3 to 8 Pass-Bys for Each Train Type in Each Station Type
Wayside:	From 3 to 6 Pass-Bys for Each Train Type for Each Type of Significant Community Structure.

2.5 STANDARDIZATION WITH OTHER NOISE MEASUREMENT GROUPS

To insure that the measurement equipment and procedures being used to measure the noise climate for the Chicago rail rapid transit system were compatible with the equipment and procedures used by other contractors measuring noise levels on other rail rapid transit systems, each of the contractors associated with the U.S. Department of Transportation Rail Rapid Transit Noise Assessment Program met in Boston on January 14, 1975, to perform noise measurements on the transit lines of the Metropolitan Boston Transit Authority (MBTA). The purpose of these measurements were: 1) to check equipment calibration, and 2) to concurrently measure

rapid transit noise at the same location. In this way, by comparing the noise values measured by each of the contractors, it was possible to insure that comparable noise measurements were obtained for each rapid transit system.

In general, it was found that the equipment and procedures used by the University of Illinois Chicago Circle (UICC) measurement team were comparable (within 2 dBA) to those of the other contractors and that the noise levels reported compared favorably (within 1 dBA) with the average of the noise values recorded by all of the contractors. Therefore, it was concluded that the calibration, measurement, and analysis procedures used in this report were satisfactory.

3. NOISE DATA MANAGEMENT AND COMPUTER PROCESSING

3.1 INTRODUCTION

The ultimate goal of this research is to find economical ways of reducing the overall noise levels on the Chicago Transit Authority (CTA) rail rapid transit lines. This goal requires more than just measuring the generated noise levels on the system. It also requires a systematic study of noise sources, paths, and receivers for the ultimate application of minimum cost noise abatement methodologies. This can be achieved by 1) defining the physical characteristics of the system; 2) by gathering information on noise levels generated on the system; and 3) by relating the measured noise levels and the physical characteristics of the system together to systematically define noise generators, noise transmitters, and noise receivers. The following paragraphs describe a computer-based system that was developed to achieve this goal. This approach is described in more detail elsewhere.*

3.2 PHYSICAL DESCRIPTION OF THE RAIL RAPID TRANSIT SYSTEM

A rail rapid transit system may be described in terms of its vehicles, structural elements that support the vehicles, and the character of the wayside development. Each of these characteristics must be described in detail and related to their ability to generate, transmit, and receive noise. For example, the vehicles on a

---

* R. Priemer and M.L. Silver, "Data Management Methods for Urban Mass Transportation Systems."

rail rapid transit system may be described by their physical characteristics such as weight, length, and the dynamic characteristics of the vehicle-truck system. This information may be used with the rail rapid transit service schedule to determine both the train frequency and the number of cars that are operating on any line at any given time, and thus define how frequently rail rapid transit noise is being generated.

It is then necessary to analyze the elements that support and guide the vehicles, including everything that contributes to noise sources and paths. The form of these elements varies along the right-of-way, and thus a continuous cataloging must be made to define their characteristics for every length of track. The elements that are significant in defining noise generation and transmission for track sections are outlined below.

1. Type of structure: Structures can be classified as at-grade roadbeds, elevated structures, and subway structures. In addition, a meaningful subdivision is to divide the structure type into sub-classes defined by the type of material which is used. A further sub-division may be made on the details of the construction method, such as cast in place or pre-cast construction.
2. Track Type: This includes a description of the type of rail, rail joint details (welded or bolted), rail fixation methods, and tie details.
3. Number of Tracks: The most common roadbed condition is a two track parallel system. However, three and four track configurations are also common on the CTA system.

4. Track Condition: There is a continuous gradation between excellent and poor track on any rail system. However, it is sufficient to divide track condition for noise studies into three classifications, such as excellent, good, or below average.
5. Track Geometry: Geometry is an important consideration affecting generated noise. A typical classification is straight track, curved track, or track with a tight radius.
6. Soil or Foundation: The type of foundation supporting the structure or roadbed can contribute to measured noise levels. This can be classified as to the type of footing that supports the structure or the type of ballast that supports at-grade and subway tunnel track.

In order to find the physical characteristics of stations and the track sections that pass through stations, characteristics 1 through 6 above are required. For example, a station may be on an elevated structure, at-grade, or in a subway. In addition, however, several additional unique characteristics are required to describe the physical characteristics of stations and these are listed below:

7. Transit Station Configuration: In general the most common station configuration uses a center platform with track on both sides. However, side platform stations with center tracks are also common. In addition, several unique station types with multiple platform configurations exist in the CTA system.

8. Service Type: As described previously, the CTA uses a multiple service station scheme where, except during late night or early morning hours, alternate trains travel and stop in alternate stations. This affects the frequency of service and the generated noise levels since trains that pass through stations without stopping will generate higher noise than trains which make complete stops.

Finally, in order to relate the generation of noise to who is receiving the noise, it is necessary to describe the physical conditions along the wayside. This can be done as follows;

9. Type of Wayside Community: A simplified zoning classification is useful to define wayside community types as a measure of the number of people who may be affected by rapid transit noise. Residential wayside communities can be defined as low density or high density development which is an indication of the number of people who may hear rail transit noise. On the other hand, commercial manufacturing districts will have few noise receivers, especially in quiet night hours. Moreover, areas such as highway median strips, underpasses, or overpasses may have no wayside community that will receive generated noise levels.
10. Wayside Distance: Distance to the community is important in determining how much noise will be transmitted to the wayside. Wayside distances can be conveniently divided into 3 classifications: less than 7.5m (25 ft), 7.5m (25 ft) to 25m (75 ft) or greater than 25m (75 ft).

Each of the ten system characteristics that have been selected to define sources, paths, and receivers of noise may have many sub-characteristics that can describe the system in more detail. For efficient computer storage and manipulation of the data it is convenient to assign to each of the characteristics a number and to each of the sub-characteristics a sub-number, which when taken together and combined can conveniently describe any section of the track in terms of physical elements and wayside characteristics. Table 3.1 summarizes such a system which has been devised for describing the physical characteristics of the CTA rail rapid transit system.

Table 3.1, determined after a review of sources, paths, and receivers of noise, is a summary of physical conditions necessary to understand noise generation and transmission in a rail rapid transit system and is easily coded for computer storage. For example, it is possible to define the wayside community through which a rail rapid transit line passes by a code such as 1(4) which indicates that the wayside community type is manufacturing. In addition, the number 2(2) would indicate that the wayside is located 25 ft to 75 ft from the right-of-way and the number 3(1) would indicate that the track is on an elevated rail structure. Continuing in this way it is possible to describe the physical characteristics of a section of line in terms of the soil or foundation profile, track type, number of tracks, track condition, and track geometry. In addition, to describe a station it is possible to combine numbers that describe transit station configuration

TABLE 3.1

RAIL RAPID TRANSIT PHYSICAL ELEMENTS AND WAYSIDE CHARACTERISTICS SELECTED TO DEFINE SOURCES, PATHS, AND RECEIVERS OF NOISE

1. Wayside Community Type:
   1 = residential, low denisty
   2 = residential, high density
   3 = commercial and business
   4 = manufacturing
   5 = highway median strip
   6 = quiet zone
   7 = public park
   8 = underpass
   9 = overpass
2. Wayside Distance:
   1 = less than 7.5m (25 ft.)
   2 = 7.5m (25 ft.) to 25m (75 ft.)
   3 = greater than 25m (75 ft.)
3. Structure Type:
   1 = elevated steel
   2 = elevated embankment
   3 = median strip
   4 = subway tunnel
   5 = at grade
   6 = cut section
   7 = embankment
   8 = elevated concrete
4. Soil or Foundation Profile:
   1 = concrete footing
   2 = ballast
   3 = concrete tie bed
   4 = elevated concrete, ballast
5. Track Type:
   1 = welded rail with wood tie
   2 = bolted rail with wood tie
   3 = welded rail with concrete tie
6. Number of Tracks:
   1 = 2
   2 = 3
   3 = 4
   4 = multiple track

TABLE 3.1 (Continued)

7. Track Condition:
   1 = excellent
   2 = good
   3 = below average
8. Track Geometry:
   1 = straight tangent, full speed section
   2 = curved, reduced speed section
   3 = tight radius, low speed section
   4 = in station
9. Transit Station Type:
   1 = center platform
   2 = side platform
   3 = dual center platform
   4 = center and side platform
   5 = triple center platform
10. Service Type:
   1 = full
   2 = partial A
   3 = partial B
   4 = not in service

and the characteristics of the transit service on that section of track.

3.3 PHYSICAL LOCATION OF SYSTEM ELEMENTS

While any one of the 10 physical characteristics describing a rail rapid transit system may be constant for a significant portion of the line, the chances that all the characteristics will remain the same for any length of track is rather remote. In general, over a 400 or 500 ft section it may be expected that at least one of the characteristics will change. Therefore, it is necessary to define the characteristics in terms of a single section of track over which they are constant. This requires an accurate and easy to understand system of wayside distance measurements from mileposts.

In Chicago we were fortunate to have a complete civil engineering survey of the entire rail rapid transit line, with survey notation that may be used to define the location of every foot of track on the rail rapid transit system. For example, for each line there is an initial point and radiating out from this point are distance markers defined in terms of 100 ft sections. The number 117+00 would mean that the distance along the track taking into account the exact distance along curves and non-straight sections is 11,700 ft from the initial point. The CTA has combined the survey distance numbers for each line with a shorthand designation for the particular line. These shorthand descriptions are shown in Table 3.2 and consist of 10 names describing each of the rapid transit lines. Thus,

TABLE 3.2

RAIL RAPID TRANSIT LINE DESIGNATIONS

Line Designation	CTA Code	UICC Code
Congress	C, DS	CON
Dan Ryan	DR, SML	DAN
Douglas Park	DP	DPK
Englewood	EW	ENG
Howard	EV, NML, SS	HOW
Jackson Park	JP, SML	JAC
Lake	LK, LP	LAK
Milwaukee	M, DS	MIL
Ravenswood	RN	RAV
Skokie	SK	SKO

DP 33200 to DP 34280 is the 1080 ft of track on the Douglas Park line between Keeler Street and Karlov Street.

As a further aid to us in identifying any location in the rail rapid transit system, we have subdivided each line of the system into sections where the physical characteristics are the same. For reference convenience, each of these sections was assigned a number, such as SKO 5 or DPK 15. Thus, the rail rapid transit system locations can be referred to by 1) CTA survey map numbers, or by 2) section numbers, which are defined by an abbreviated service route name followed by a number, such as DPK 13, which is the Douglas Park line between Keeler Street and Karlov Street. Thus within any section, the physical characteristics do not change, while for two adjacent sections the physical characteristics will differ in at least one category.

3.4 DETERMINATION OF PHYSICAL CHARACTERISTICS

Actual physical attribute values were assigned by riding every service route, by using air photographs, and by using city maps. Each record in the CTA physical attributes data file describes a rail rapid transit section and consists of the section name, the end point of the section specified by the survey map numbers, a field for comments such as some reference to street location or station name, and the 10 characteristics description code (Table 3.1). For example, the computer printout on Table 3.3. shows the CTA map number, service route names, and the physical characteristics for a station on the Milwaukee line and a section of track on the Douglas Park line. This printout was obtained

TABLE 3.3

EXAMPLE OF THE PHYSICAL CHARACTERISTICS DATA

FILE FOR A STATION ENTRY AND A LINE SEGMENT ENTRY

Time Shared Computer Terminal Commands

```
exec dms
ENTERED CTA DATA FILE PROGRAM
ARE INSTRUCTIONS REQUIRED, YES OR NO?
no
PROCEED
show map #mil1 #dpk21

************************************************************************
FOR CTA LOCATION M   32225 TO M   32918
THE MAP LOCATION IS MIL1  (JEFF. PK. STATION   ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: HIGHWAY MEDIAN STRIP
WAYSIDE DISTANCE: GREATER THAN 25M (75 FT.)
STRUCTURE TYPE: MEDIAN STRIP
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: WELDED RAIL WITH CONCRETE TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: NEW, LESS THAN 5 YEARS OLD
TRACK GEOMETRY: IN-STATION, REDUCED SPEED SECTION
TRANSIT STATION TYPE: CENTER PLATFORM
SERVICE TYPE: FULL
************************************************************************


************************************************************************
FOR CTA LOCATION DP  25300 TO DP  26000
THE MAP LOCATION IS DPK21 (RR OVERPASS - CALF. ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: ELEVATED STEEL
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: POOR
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
************************************************************************
```

using the computer-based data management system that will be described in a subsequent section.

For the CTA rail rapid transit system the physical description of 86 miles of service route right-of-way was reduced to 518 data cards that completely describe the physical characteristics of the system as it relates to noise source, path and receiver description, and identification.

3.5 NOISE MEASUREMENT DATA STORAGE

The noise values obtained in the measurement program must, like physical characteristic information, be put into a systematic format if economic and time-saving data management and retrieval is to be achieved. In this way by relating noise levels to their physical location on the system, it is possible to 1) compare noise levels throughout the system, and 2) describe the physical characteristics that may be responsible for the noise. Therefore, all measured noise data was arranged into the following categories for computer storage and retrieval:

1. Physical Location: This includes information on whether the noise measurements were made in-car, in-station, or along the wayside. It describes the CTA map designation number as well as the station name or street adjacent to the measurement location. For station or wayside measurements, the survey map number would not change. For in-car measurements, the map designation would be changing continuously to represent the train as it moved through the system.

2. Measurement Details: Stored information includes details on microphone placement in terms of both height and distance from the track. In addition, weather conditions and time of the measurement are incorporated into this data file.
3. Vehicle Characteristics: Important information stored in this category is the type of vehicle, the number of cars, and the passenger load that was carried.
4. Speed: Train speed is an important characteristic for evaluation of generated noise in any transportation system, and care was taken to properly monitor this variable. All speed measurements were obtained using the radar speed measuring unit. For in-station and wayside measurements, the train speed was the pass-by speed while in-car train speed was determined by pointing the radar unit at passing buildings.
5. Noise Levels: Values of the noise level in terms of A-weighted values were taken from the graphic level recorder time histories obtained in the laboratory. Ambient noise values, peak noise values, and the shape of the time histories were all summarized and digitized.
6. Noise Sources: A continuous assessment was made of the significant sources of rail rapid transit noise for every measurement. Factors such as wheel flats, rough wheels, and other characteristics were noted, summarized, and recorded.
7. Noise Paths: An estimate of noise paths, such as reverberation, structure-borne, or direct field, was made and recorded for each noise measurement.

All of the data described above was digitized in a specified format (Table 3.4) for each in-station and wayside noise measurement location and for each in-car section of track. For the in-station and wayside measurements, an average for all the noise measurements for each combination of car type and number of cars was determined and stored in the computer. For the in-car noise measurements, noise levels were recorded for each location along a right-of-way section where the physical characteristics did not change appreciably. The form of this data is shown in Appendix A.

TABLE 3.4

FORM OF THE NOISE DATA SUMMARIZED AND DIGITIZED TO DEFINE CTA RAIL RAPID TRANSIT NOISE LEVELS, SOURCES, AND PATHS

Survey map range
Measurement type:
  1 = wayside measurement
  2 = in-car measurement
  3 = in-station measurement
Data and time
Car type-car number
Number of cars in train
Train speed (peak mph)
Horizontal measuring distance from track center
  + for outbound track
  - for inbound track
Vertical measuring distance from track
  + for distance above track
  - for distance below track
Car patron density
  1 = very light
  2 = medium, as in off-rush hour
  3 = very dense, as in peak rush hour
Any comment about the measuring situation (such as weather conditions)
Noise sources:
(wheel flat, rough wheel, rail joint, power pick-up, rough rail, wheel squeal, misc. exterior noise, door movements, air conditioning, passenger noise, station mechanicals)
  1 = not present
  2 = present but not significant
  3 = very noticeable
Noise paths:
(building-wall reverbertion, direct field, structure borne)
  1 = path not operational
  2 = path operational
Ambient noise level dbA
Peak dbA
Number of peaks within 5 dbA of maximum peak
Plateau dbA
Duration of measurement (in-car) or duration of plateau (-5 dbA) in deciseconds
Shape of dbA curve
  1 = flat (retangular)
  2 = semi-elliptical or circular
  3 = triangular
Any comment about the noise data (such as unusual background noise)

4. IN-CAR NOISE MEASUREMENTS

4.1 INTRODUCTION

The goal of the in-car measurement program was to determine noise levels received by riding passengers who enter the vehicle, stand or sit during their journey, and leave the vehicle at their stop. To obtain these data, the measurement team rode each type of rapid transit vehicle on each service line, monitored and recorded the noise levels generated, and identified the section of the line that the vehicle was passing over. The following pages describe the methodology used to make these measurements, as well as the values of the recorded noise.

4.2 CHICAGO TRANSIT AUTHORITY TRANSIT VEHICLES

The three types of rail rapid transit vehicles that make up the majority of the present fleet of the Chicago Transit Authority (CTA) system were monitored. These vehicles are designated 2000, 2200, and 6000 series cars. The characteristics of each of these vehicles are summarized in Table 4.1, and physical dimensions of the car are shown graphically in Figures 4.1 and 4.2. The oldest vehicles, the 6000 series cars, were built in the 1950's, the 2000 series vehicles were built in 1964, and the 2200 series vehicles were built in 1969.

TABLE 4.1

SUMMARY OF RAPID TRANSIT VEHICLE CHARACTERISTICS

CHICAGO TRANSIT AUTHORITY

Series Type	Year Built	Weight	Construction and Appearance	Routes Served
6000	1950-1951 (initial production)	42,700 to 43,700 lb. (19,268 to 19,822 kg)	Steel construction, non-sealed windows	Howard Englewood Jackson Park Douglas Park Ravenswood
6000	1954-1959	44,340 lb. (20,117 kg)	Different trucks and wheels than the initial production	Congress Milwaukee Skokie
2000	1964	48,400 lb. (21,984 kg)	Aluminum construction, sealed windows, air-conditioned	Lake Dan Ryan
2200	1969-1970	45,000 lb. (20,412 kg)	Stainless steel construction, sealed windows, air-conditioned	Lake Dan Ryan Douglas Park Congress Milwaukee

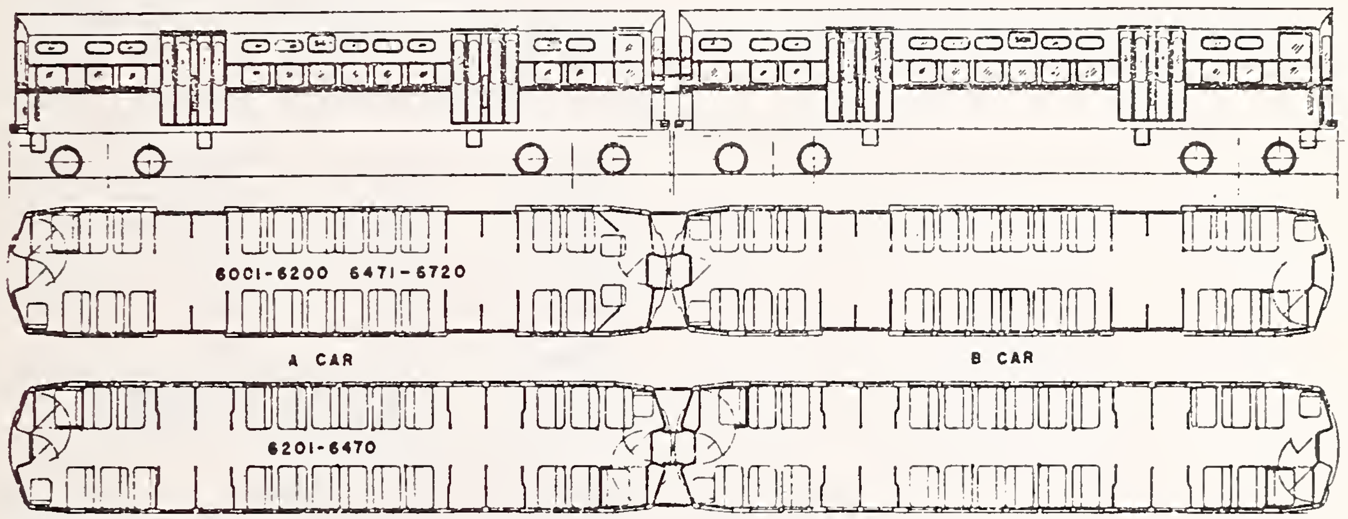
CTA PASSENGER CARS

VEHICLE TYPES IN USE

Three types of rapid transit vehicles, commonly called 6000, 2000, and 2200 series cars, make up the majority of the fleet used on the Chicago Transit Authority System. The Characteristics of these vehicles are summarized in Table 4.1. The oldest vehicles, the 6000 series, were built in the 1950's, the 2000 series vehicles were built in 1964, and the 2200 vehicles were built in 1969.

A few special trains used for special functions exist, but they are not used for daily passenger service. In addition, a small number of series 50 cars manufactured in 1947-1948 and 1959-1960 are operated on the Skokie, Ravenswood and Evanston lines.

6001-6200 St. Louis

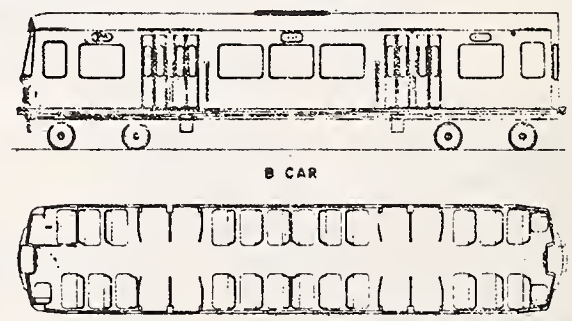


Year	1950
Length	48'-0"
Width	9'-4"
Height (roof)	11'-10"
Seats	A-47, B-51
Weight	41,700-42,700 lbs.

Fig. 4.1 Physical Characteristics of 6000 Series Rapid Transit Cars - Chicago Transit Authority

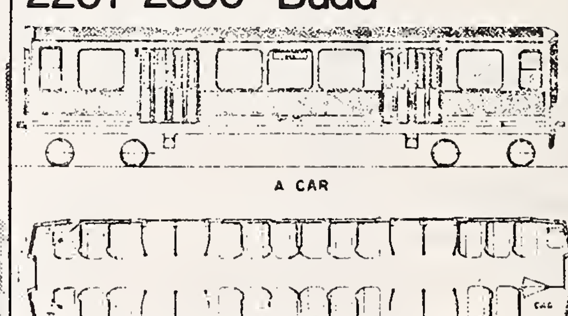
CTA Passenger Cars

2001-2180 Pullman



Year	1964	1969-70
Length	48'-0"	48'-0"
Width	9'-4"	9'-4"
Height (roof)	12'-0"	12'-0"
Seats	51	47
Weight	47,000 lbs.	45,000 lbs.

2201-2350 Budd



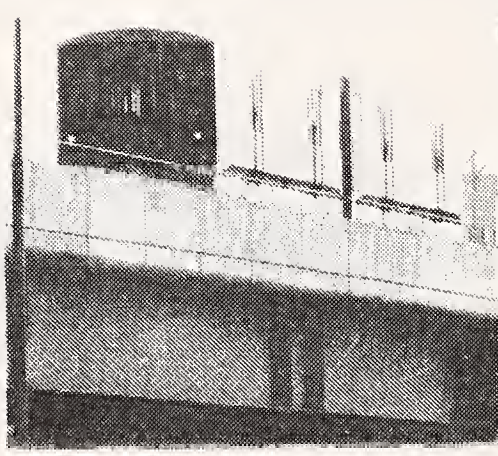


Fig. 4.2 Physical Characteristics of 2000 and 2200 Series Rapid Transit Cars - Chicago Transit Authority

The physical characteristics of each car type used in the CTA system are such that any car type can be used on any CTA rapid transit line. Thus, it is possible to find any one of the three types of rail rapid transit cars on any service line at any time. However, the use of any one type of car is generally confined to a particular route, as shown in the last column of Table 4.1.

As previously discussed in Section 1.3.3, train operation in Chicago follows a fairly frequent headway schedule, with changing train lengths used to serve different passenger loads at different times of the day. For example, in late evening and early morning, 2-car trains are used. As the rush hour approaches, the number of vehicles is increased successively to 4, 6, and finally to 8 cars per train (on some routes). The number of cars is gradually increased again until 8-car trains run during the evening rush hour. Thus, for these noise measurements, the type of car in use and also the number of vehicles in the train were recorded. This was, however, not an important acoustic consideration for the in-car noise measurements, since the number of cars did not seem to influence significantly the noise levels generated in the interior of the vehicle.

4.3 NOISE MEASUREMENT STRATEGY

Noise measurements were made and recorded for each transit line by riding in each car type that is commonly used on that line. All measurements were made in off-peak hours to avoid interruption of normal passenger service. Thus, most measurements were made in 2-car and 4-car trains. Table 4.2 summarizes all of the in-car noise measurements made.

All measurements were made with the microphone in the second car of the train, with the microphone positioned on the center line of the vehicle midway between the front and rear doors (Fig. 4.3). The microphone was supported on a tripod, which was isolated with foam from floor vibrations. The microphone height was placed at 1.2m (4.0 ft) above the floor to represent the position of the ear of a riding passenger.

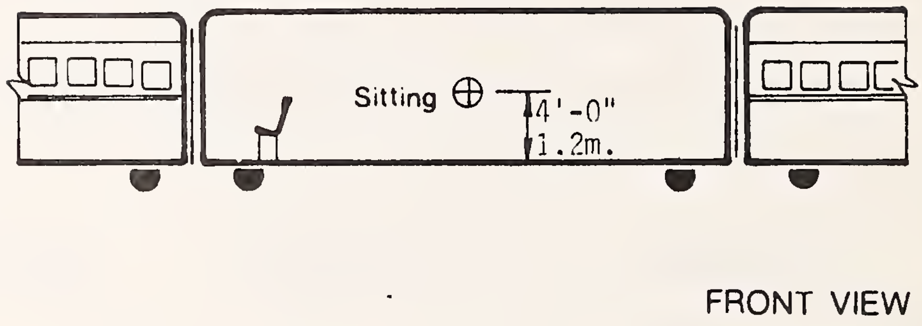
For all measurements, the vehicle speed was monitored using the police radar unit described in Chapter 2. The radar sensing unit was pointed out the window of the vehicle at an oblique angle to reflect off approaching buildings. Tests using an automobile showed that this method resulted in no error in measured speed. These speed measurements were regularly noted on a separate voice channel for the duration of the in-car noise measurement ride. During the noise measurement ride, the measurement team regularly noted, on the voice track

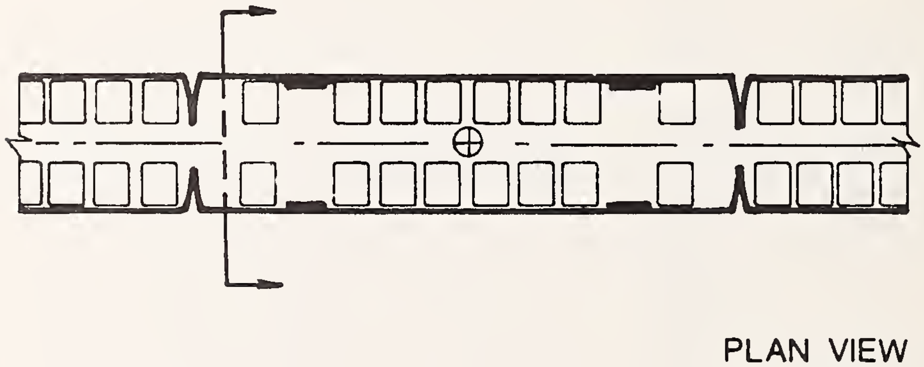
TABLE 4.2

SUMMARY OF IN-CAR NOISE MEASUREMENTS OBTAINED

Line	Car Type	No. of Cars in Train	No. of Measurement Rides
Congress	2200	2	2
Congress	6000	2	2
Milwaukee	2200	2	2
Milwaukee	6000	2	2
Douglas Park	2200	2	1
Douglas Park	6000	2	1
Skokie	6000	2	2
Howard	6000	4	3
Jackson Park	6000	4	2
Englewood	6000	4	1
Lake	2000	2	1
Lake	2200	2	1
Dan Ryan	2200	2	1
Dan Ryan	2000	2	1
Ravenswood	6000	2	1
		Total	23

CAR MICROPHONE LOCATIONS





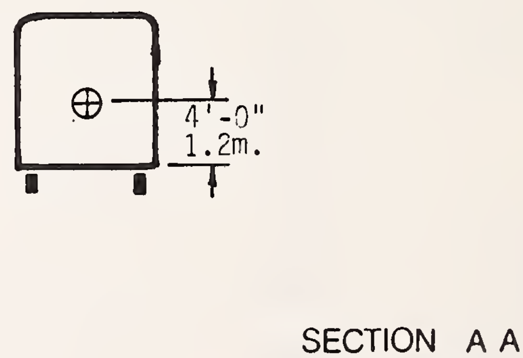


Fig. 4.3 Schematic Drawing Showing Microphone Location for In-Car Noise Measurements

of the recorder, sources and paths of the perceived noise as heard in the type recorder earphones. Typical noise sources with identifying graphic symbols are shown on Fig. 4.4. Noise paths are summarized with representative graphic symbols in the same figure. These definitions of sources and paths are consistent with those used in the MBTA study.*

All measurements were recorded on a tape recorder, using a flat response mode with the meter settings as discussed in Chapter 2.

In the laboratory, the tape was played back and a time history was obtained from the graphic level recorder. At the same time a notation of train speed, anomalous sources of noise such as tight curves, wheel squeal, or track noise, and the map location where the measurements were being made, were noted on the strip chart record.

A typical time history showing the A-weighted noise levels resulting from the in-car noise measurements is shown on Fig. 4.5. It may be seen on the figure that a low in-car noise level was recorded in the station while the train was standing still. This noise level increased uniformly as the train accelerated from the station, reaching a plateau value as the train reached a constant speed between stations. Then, as the train slowed down, it may be seen that the A-weighted noise level decreased as the train entered the station. Along the bottom

* Kurzweil, et al., "Noise Assessment and Abatement."

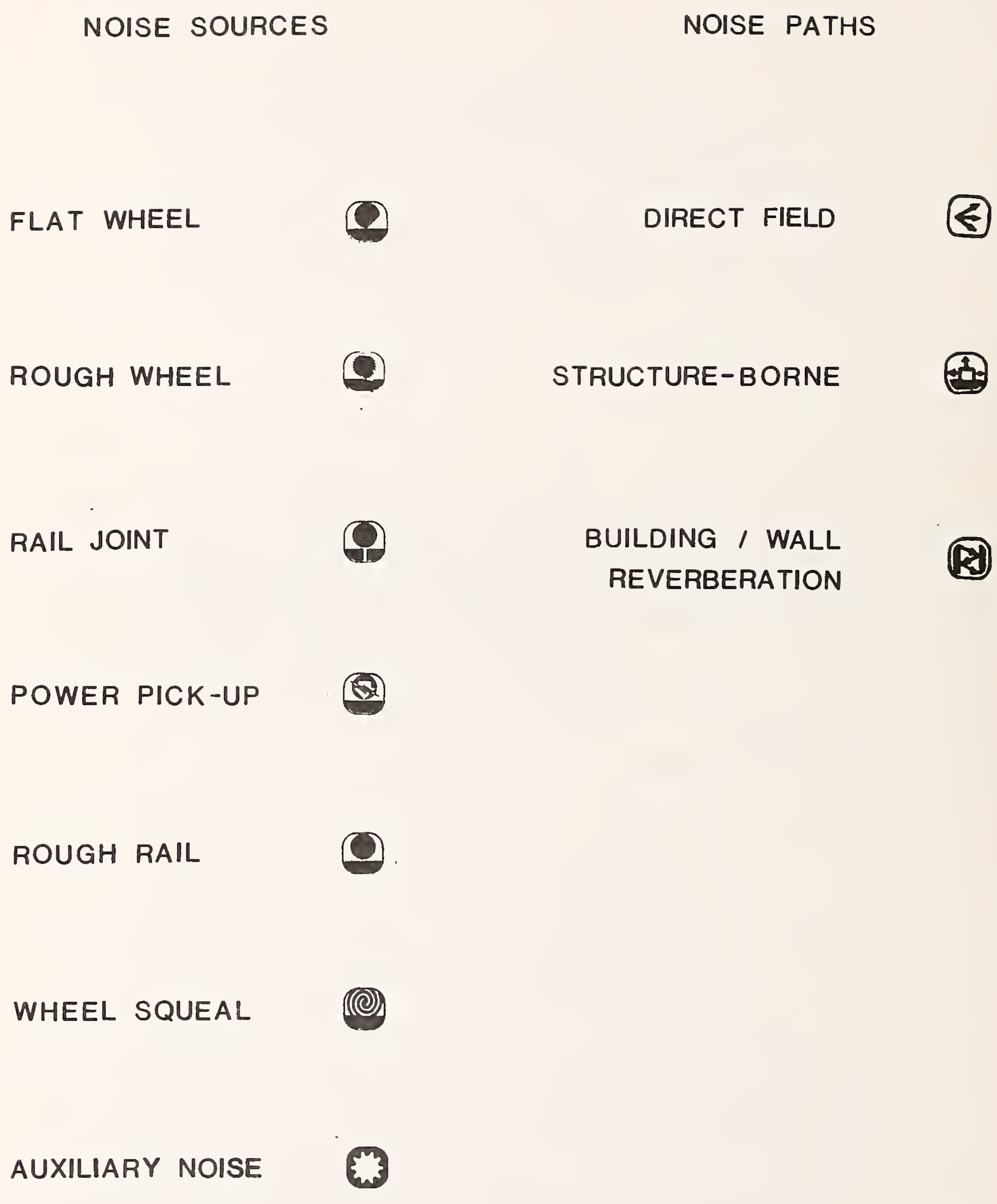
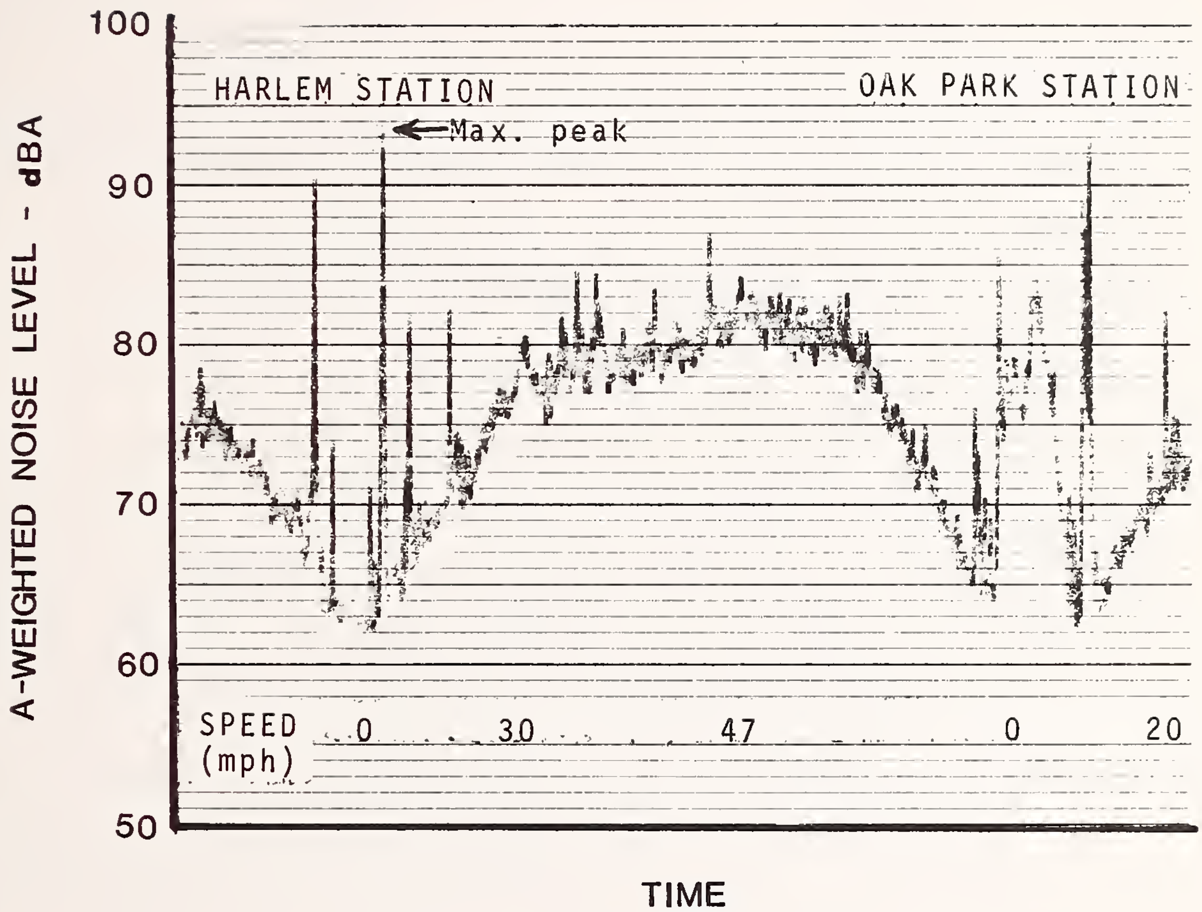


Fig. 4.4 Definition of Terms and Symbols Used to Represent Noise Sources and Transmission Paths



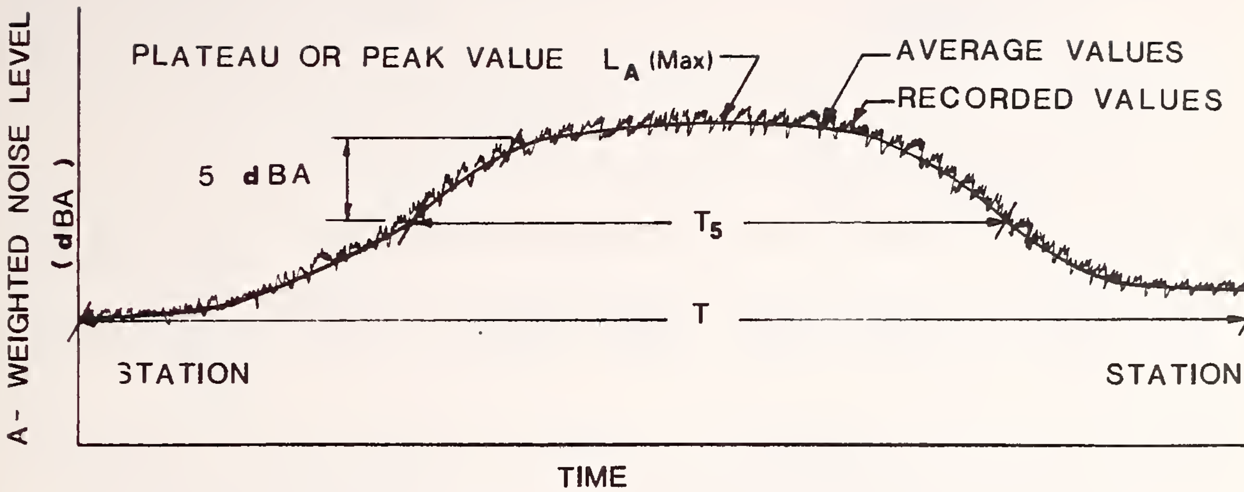
Scale: 15 sec./½ in.

Fig. 4.5 Typical Time History of In-Car Noise Levels for the Congress Line Between the Harlem Station and Oak Park Station

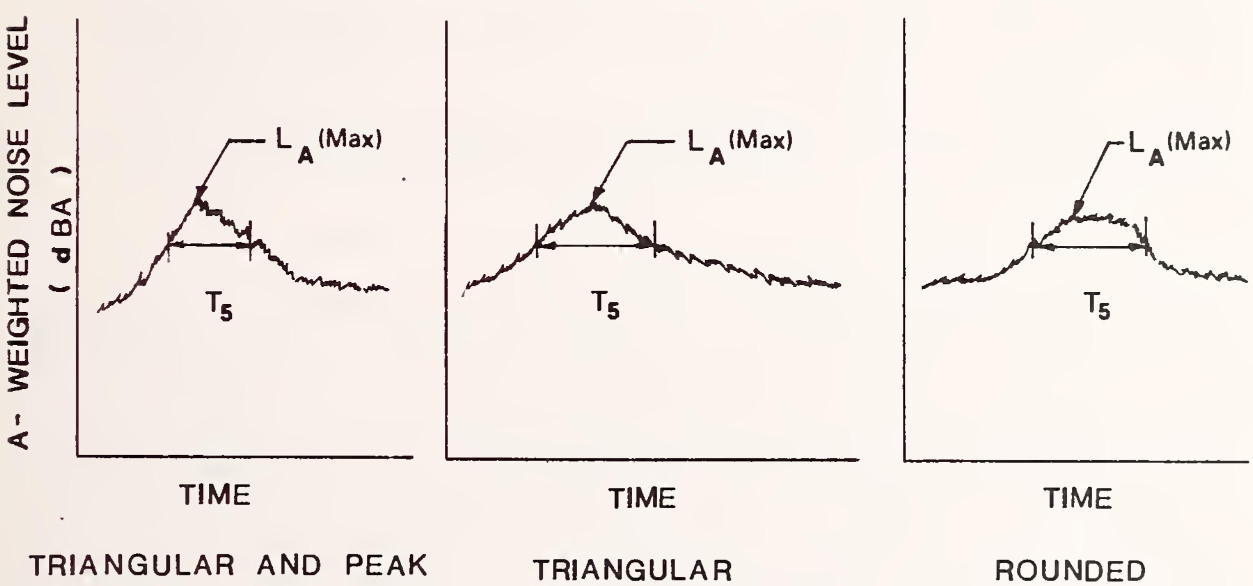
of the strip chart is recorded the train speed, and at appropriate places on the strip chart, the noise sources and paths that were perceived by the measurement team are also noted.

The shape of the A-weighted noise level curve in Fig. 4.6A is representative of most of the noise measurements made in-car and shows a relatively flat constant amplitude noise level during the constant speed portion of the train run. This form of trace is called a noise plateau. In some cases, other noise time history shapes were recorded between stations and these are shown in Fig. 4.6B For example, sometimes the noise level increased relatively uniformly and then decreased going into the next station, giving a so called triangular-shaped noise trace. In some other cases noise levels increased rather rapidly and then decreased more slowly as the train traveled to the next station, giving a triangular-shaped wave trace with an initial peak. Finally, in some cases no discernable plateau level could be determined and a more rounded noise record was recorded.

For noise analysis purpose, it is sometimes useful to calculate a noise function which represents not only the maximum A-weighted noise level but also the time duration for which this level occurs. Two different noise functions are defined in



(A)



(B)

$$L_R = L_{A(Max)} + 10 \text{ LOG } T_{-5} \qquad L_{eq} = L_R - 10 \text{ LOG } T$$

(C)

Fig. 4.6 Definition of Terms Used to Represent In-Car Noise Levels Showing A) Method of Smoothing Data, B) Typical Shapes of Noise Level Versus Time Traces, and C) Definitions of Noise Weighting Factors

Fig. 4.6C. The necessary time information required to evaluate these functions was obtained from the noise time histories Fig. 4.6A for use in subsequent phases of research to determine optimum noise abatement strategies.

4.4 IN-CAR NOISE LEVELS

In-car noise level measurements for each vehicle type for each of the rapid transit lines in Chicago are graphically shown in charts in Appendix C; examples of these charts are shown on Figs. 4.7 and 4.8. These representations show to scale the A-weighted noise levels as a function of location for each of the rail rapid transit lines of the CTA system.

In the upper right hand corner of the figures, a black dot on a location map shows where the section of track is situated. The line of symbols below the location map shows the type of track structure (such as elevated steel, elevated concrete, and other) over which the transit car is traveling (Fig. 4.9). Below this is shown the track geometry, which is normally straight or curved (Fig. 4.10). The next line shows the type of track (either bolted or welded) and the type of roadbed over which the train is passing at that time (Fig. 4.11). The map section shows to scale exactly where the track is situated in relation to the wayside community.

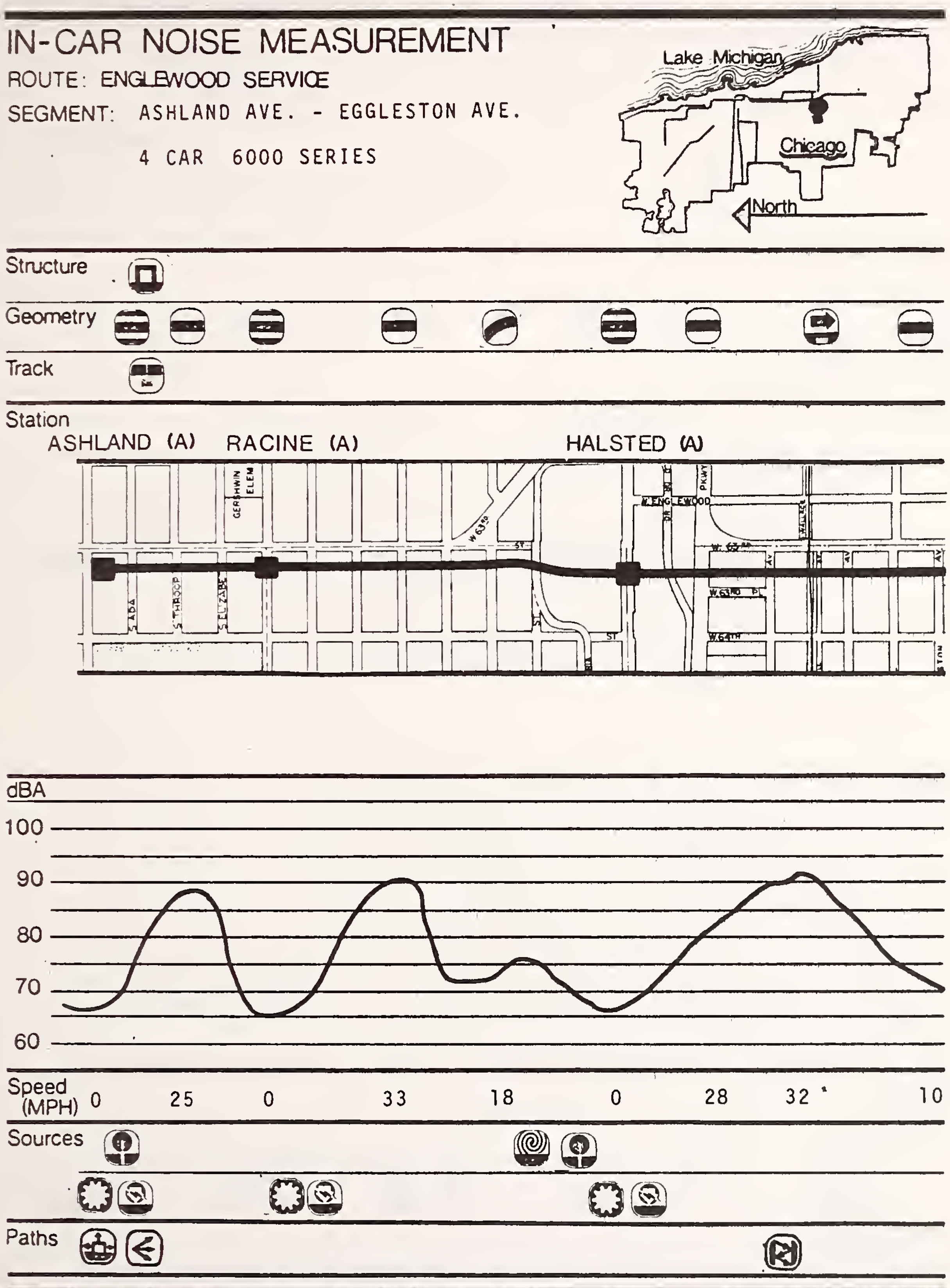


Fig. 4.7 - Average A-Weighted Noise Levels for In-Car Measurements on the Englewood Service (Elevated Steel)

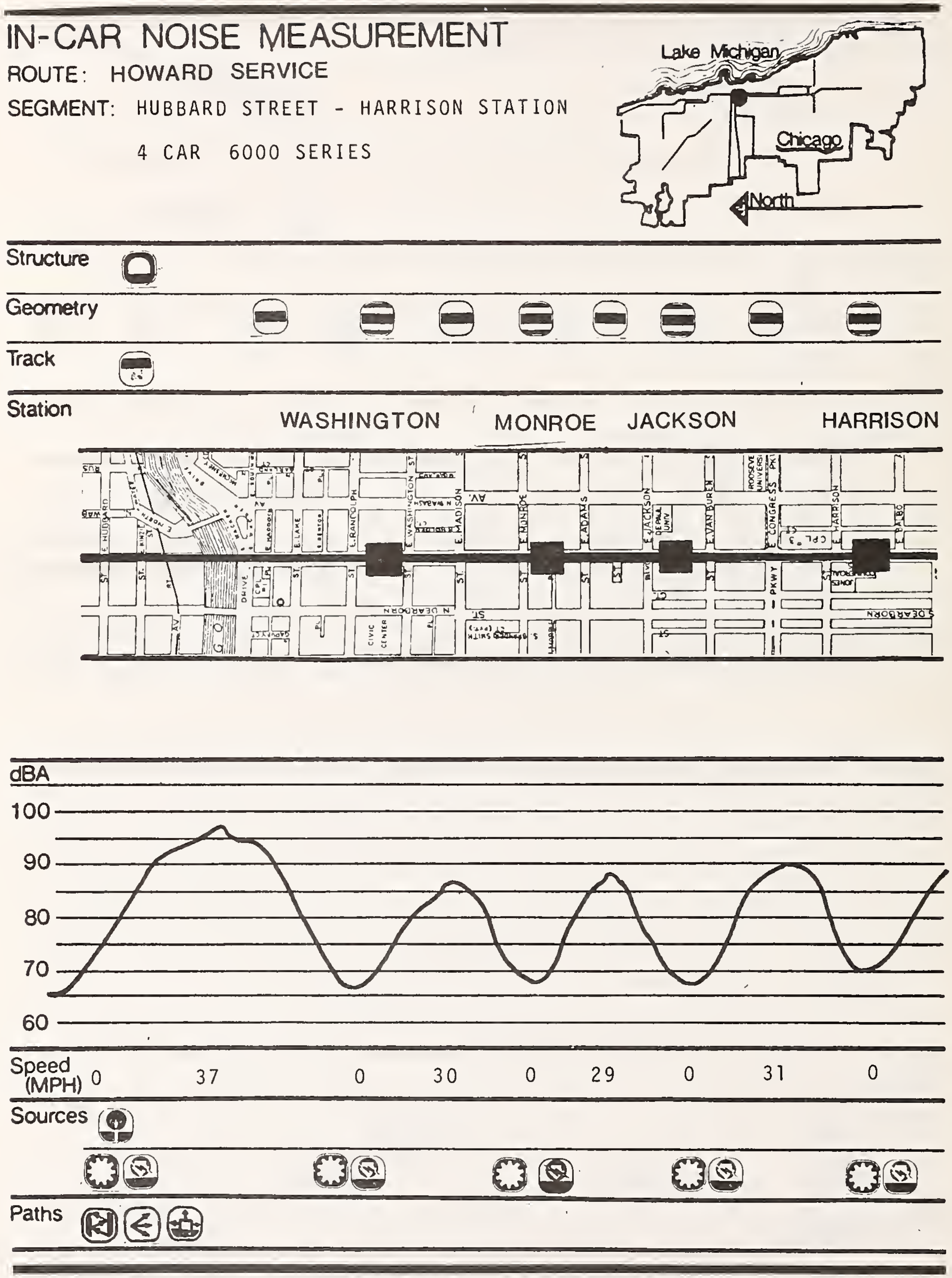


Fig. 4.8 - Average A-Weighted Noise Levels for In-Car Measurements on the Howard Service (Subway)

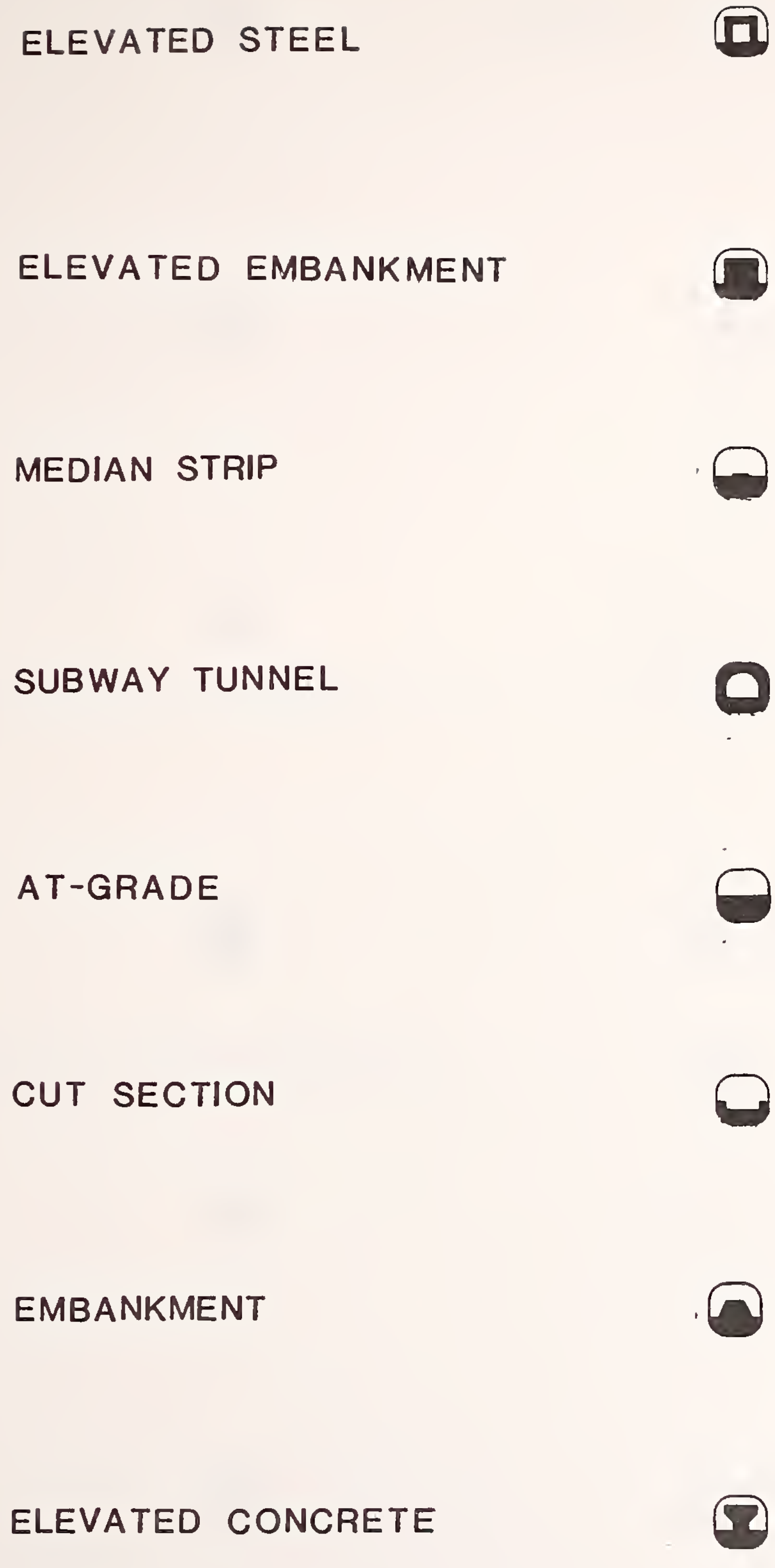


Fig. 4.9 Definition of Symbols Used to Represent Different Classes of Rail Rapid Transit Structures

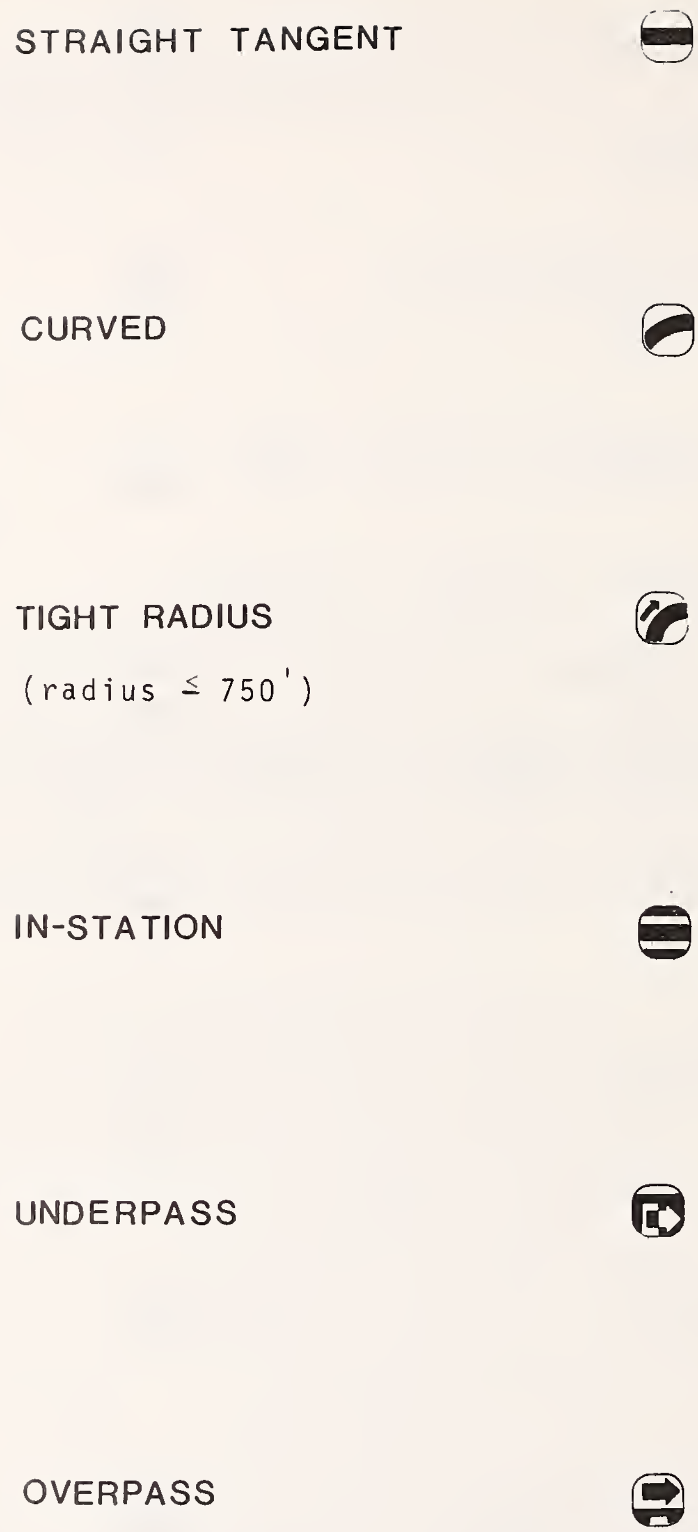


Fig. 4.10 Definition of Symbols Used to Represent Rail Rapid Transit Track Geometry

WELDED RAIL WITH CONCRETE TIE 

WELDED RAIL WITH WOOD TIE 

BOLTED RAIL WITH WOOD TIE 

Fig. 4.11 Definition of Symbols Used to Represent Rail Rapid Transit Track Type

The figures then show the A-weighted noise levels for the vehicle along the track; in cases where two vehicle types were monitored the upper curve represents the noisiest class of vehicle measured on the line and the lower curve represents the quietest class of vehicle measured for the line. These values, as a function of distance, were obtained by smoothing and replotting noise time histories from the graphic level recorder while noting the position on the service route as described on the commentary channel.

Train speed data (in mph) is shown below the trace of the recorded noise level, and noise sources and paths are shown graphically in the bottom two lines of information, using the definitions and symbols shown on Fig. 4.4.

All of the noise representations shown in Appendix C are to scale and may be cut out and pasted together to show a graphic representation of noise levels along the entire length of all rail rapid transit lines in the CTA system.

4.5 SUMMARY OF IN-CAR NOISE LEVELS

The type of representation shown in Figs. 4.7 and 4.8 and in Appendix C is useful for a detailed study of the noise levels along any section of the track in the Chicago system, as well as for an evaluation of the sources that generate the noise and the path over which the noise travels. However, a simplified

representation of the overall in-car noise levels throughout the system can be obtained by summing the maximum "smoothed" A-weighted noise levels for the system as a function of the track length over which the noise levels were measured. This has been done in Table 4.3, which shows the total length of track for which the noise levels were between specified levels.

The distance measurements in Table 4.3 are for feet of both inbound and outbound service track and represent the track distance that would be associated with maintenance, renewal, and similar cost evaluations. In-station track length is not included. The tabulated noise levels are for the noisiest vehicle on the line. It may be seen that in-car noise levels are predominantly in the range of 80 to 85 dBA, with some noise levels reaching 95 to 100 dBA over about two miles of track.

An overall measure of in-car noise for the system may be made by calculating the centroid of the noise records, which is a mileage-weighted average of in-car noise levels for the entire system. The resulting noise centroid for the CTA system is 82.51 dBA.

TABLE 4.3

SUMMARY OF IN-CAR NOISE LEVELS
AS A FUNCTION OF TRACK DISTANCE

Noise Levels in dBA[1]	Feet of Service Line[2] for Inbound and Outbound Operations
50 - 55	0
55 - 60	0
60 - 65	800
65 - 70	15,440
70 - 75	31,360
75 - 80	161,300
80 - 85	267,800
85 - 90	183,440
90 - 95	67,720
95 - 100	13,000
100 - 105	0
105 - 110	0
110 - 115	0
115 - 120	0
	740,860 ft

[1]For noisiest vehicle type on line.

[2]Does not include track in stations.

5. IN-STATION NOISE MEASUREMENT

5.1 INTRODUCTION

In-station measurements for the Chicago Transit Authority (CTA) system were made to evaluate noise levels perceived by transit patrons waiting in the station. For these measurements, microphones were set up on the transit platform and noise levels were recorded for train pass-bys and for trains that stopped in the station. These noise levels were later analyzed in the laboratory to evaluate magnitude and duration.

Since it is prohibitive to measure noise levels in every station on the transit system, a significant effort was expended to characterize the different types of stations that exist in the Chicago Transit Authority system, based on their acoustic characteristics. Based on this analysis, typical station types were selected and a large number of noise measurements were made in these characteristic stations. These noise levels were then generalized to define the noise climate in all of the stations of the transit system.

The following pages describe the physical characteristics of the transit stations in the CTA rail rapid transit system, the selection process used to define the characteristic types of stations, the noise measurement methodology used in the selected stations, and the results of the noise measurements.

5.2 TRANSIT STATION CHARACTERISTICS

The Chicago Transit Authority rail rapid transit system consists of 155 stations, with those constructed on steel elevated structures most common, as shown on Table 5-1. The track structure types of the remaining stations are approximately equally divided among subways, elevated earth embankments, at-grade and median strips.

Table 5-2 further shows that these 155 stations can be subdivided into the following five classes, based on the platform configuration in each station:

1. Center Platform Stations
2. Side Platform Stations
3. Dual Center Platform Stations
4. Center and Side Platform Stations
5. Triple Center Platform Stations

This classification was helpful in choosing representative station types in which to make noise measurements.

Each combination of transit station structure type and platform configuration listed in Table 5.3 is graphically represented in plan and profile in Figs. 5.1 to 5.8. For example, Fig. 5.1 shows station type No. 1, which consists of a center platform station constructed on a steel elevated structure. For this platform configuration, one or two service lines can be independently served. Fig. 5.2 also shows a station constructed on a steel elevated structure, but here side platforms are used and express tracks

TABLE 5.1

STRUCTURE TYPES AND STATION LENGTHS FOR RAIL RAPID TRANSIT STATIONS OF THE CHICAGO TRANSIT AUTHORITY

Transit Station Structure Type	Number of Stations	Station Length Miles	Feet
Elevated Steel	74	11.11	58,660
Elevated Embankment	14	2.48	13,100
Median Strip	21	4.30	22,700
Subway Tunnel	20	3.07	16,210
At Grade	17	2.49	13,150
Cut Section	0	0	0
Embankment	8	2.88	15,210
Elevated Concrete	1	0.15	790
Total	155	26.48	139,820

TABLE 5.2

PLATFORM CONFIGURATIONS AND TRACK CONSTRUCTION FOR
RAIL RAPID TRANSIT STATIONS OF THE CHICAGO TRANSIT AUTHORITY

Platform Type	Number of Stations	Station Length Miles	Station Length Feet
Center Platform	78	13.24	69,910
Side Platform	68	11.92	62,940
Dual Center Platform	6	0.89	4,700
Center And Side Platform	2	0.23	1,210
Triple Center Platform	1	0.19	1,000
Total*	155	26.47	139,760

Track Construction	Number of Stations	Station Length Miles	Station Length Feet
Welded Rail/Wood Tie	42	7.44	39,280
Bolted Rail/Wood Tie	99	16.37	86,430
Welded Rail/Concrete Tie	14	2.66	14,050
Total*	155	26.47	139,760

*Totals may vary from those in Table 5.1 due to rounding.

TABLE 5.3

TRANSIT STATION IDEALIZATION BASED ON
STRUCTURE TYPE AND PLATFORM CONFIGURATON

Type	Description
1	Center Platform Elevated Steel
2	Side Platform Elevated Steel
3	Dual Center Platform Elevated Steel
4	Center Platform Elevated Embankment
5	Dual Center Platform Elevated Embankment
6	Center Platform Subway
7	Side Platform Subway
8	Center Platform Median Strip or At-Grade.

MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.

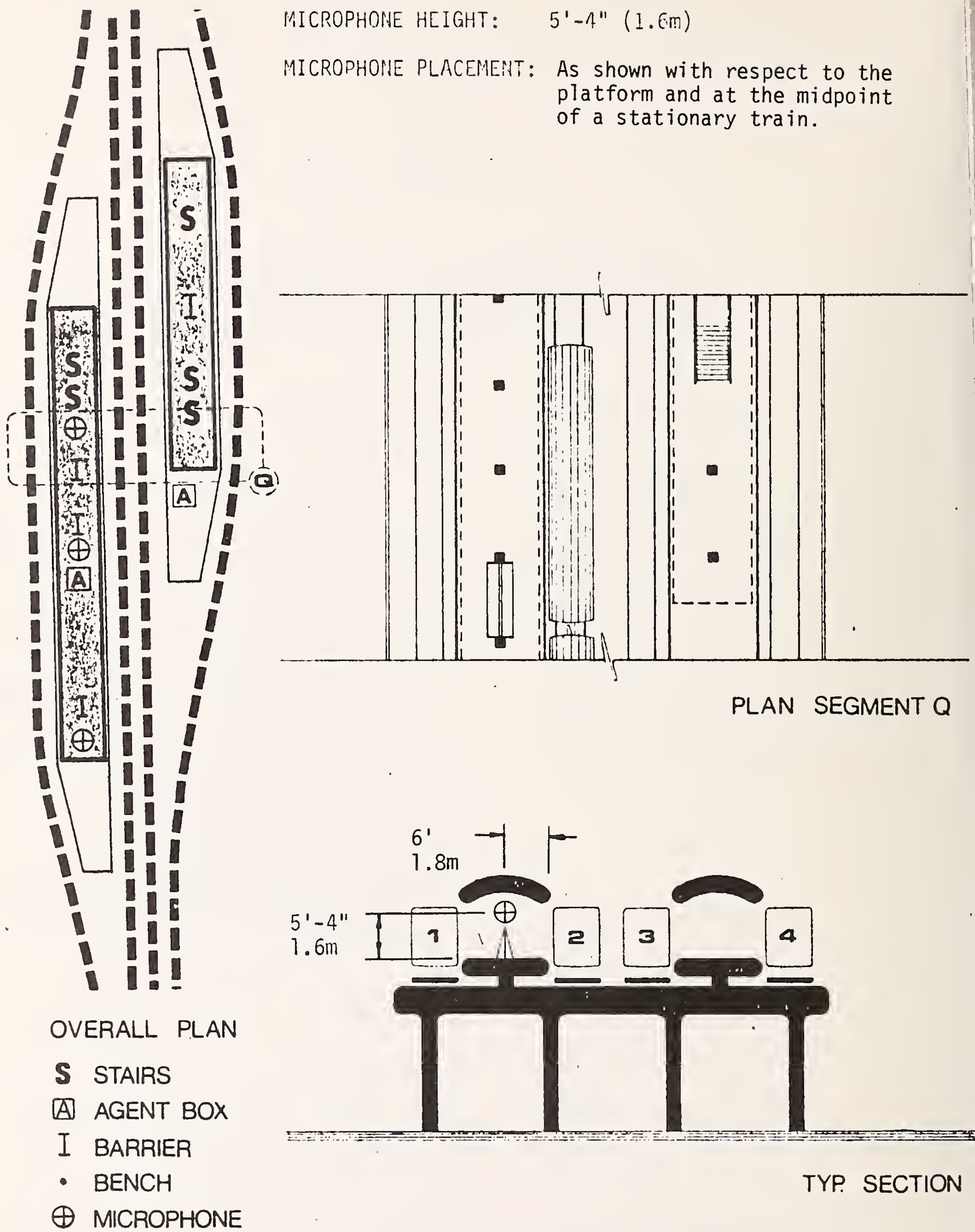
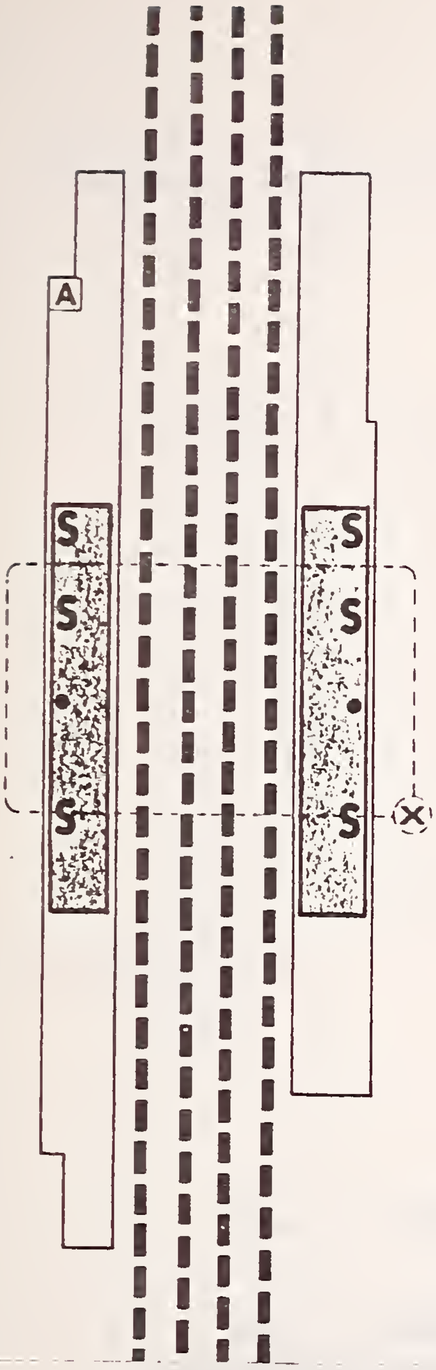


Fig. 5.1 - Center Platform Elevated Steel Station Configuration (Station Type 1)

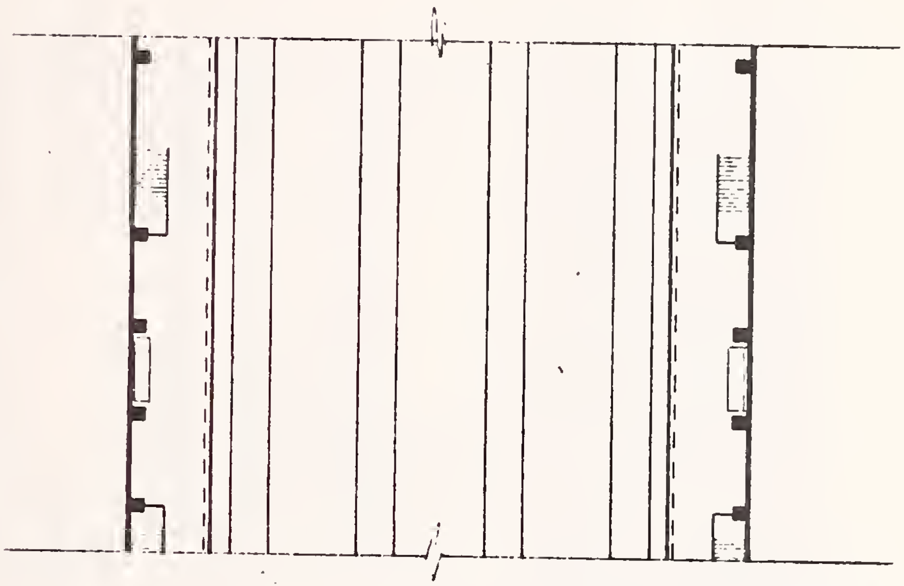
MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.

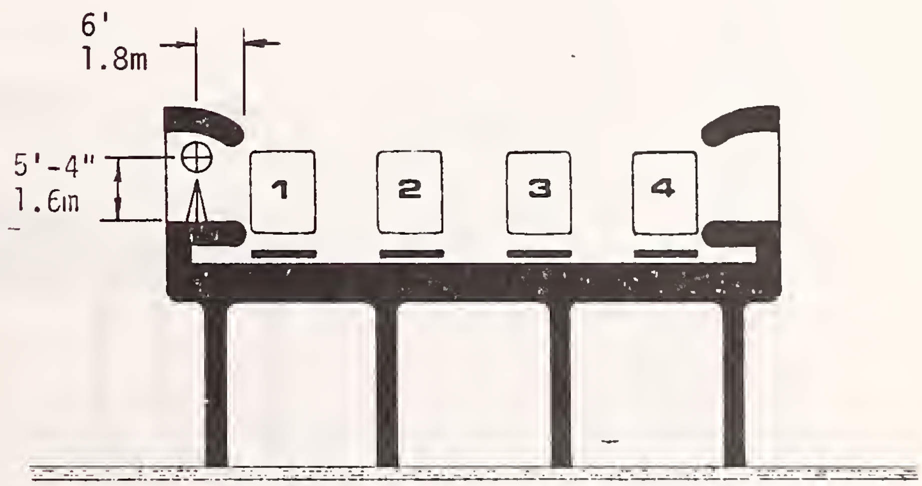


OVERALL PLAN

S STAIRS
A AGENT BOX
I BARRIER
• BENCH
⊕ MICROPHONE



PLAN SEGMENT X

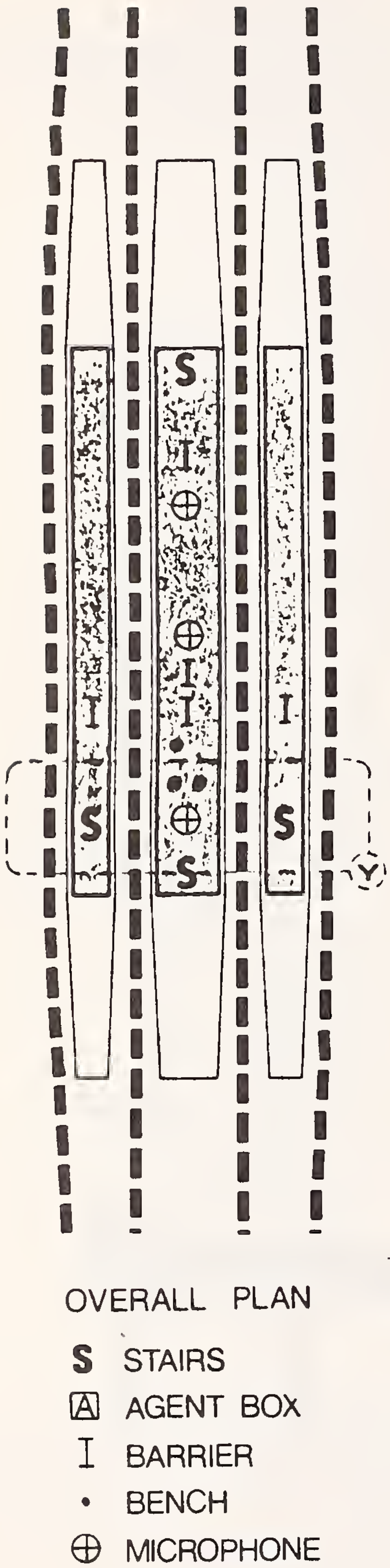


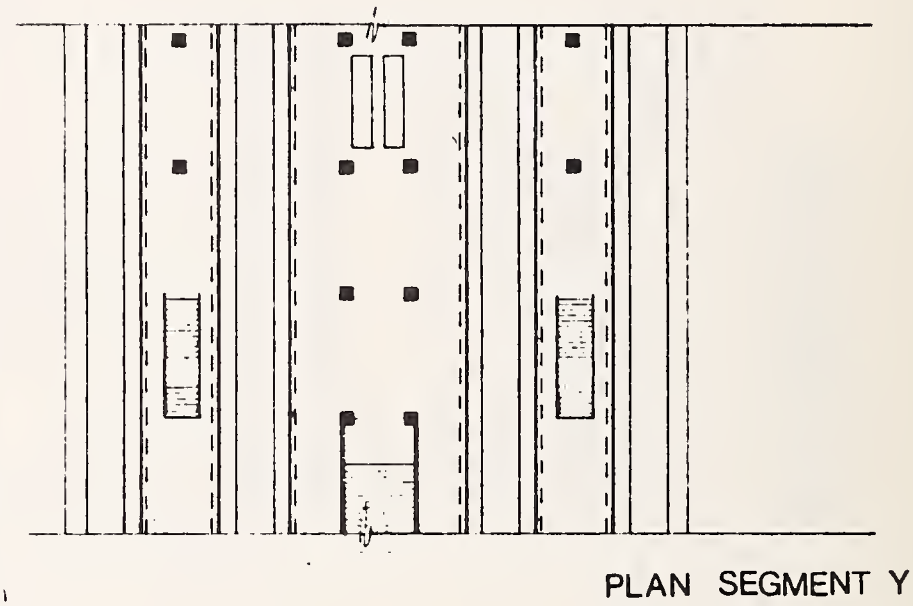
TYP. SECTION

Fig. 5.2 - Side Platform Elevated Steel Station Configuration (Station Type 2)

MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.





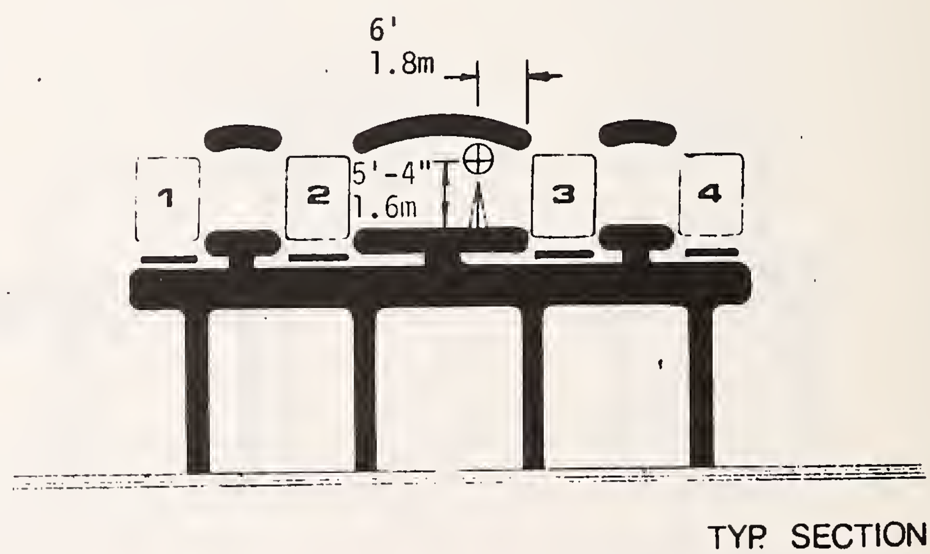
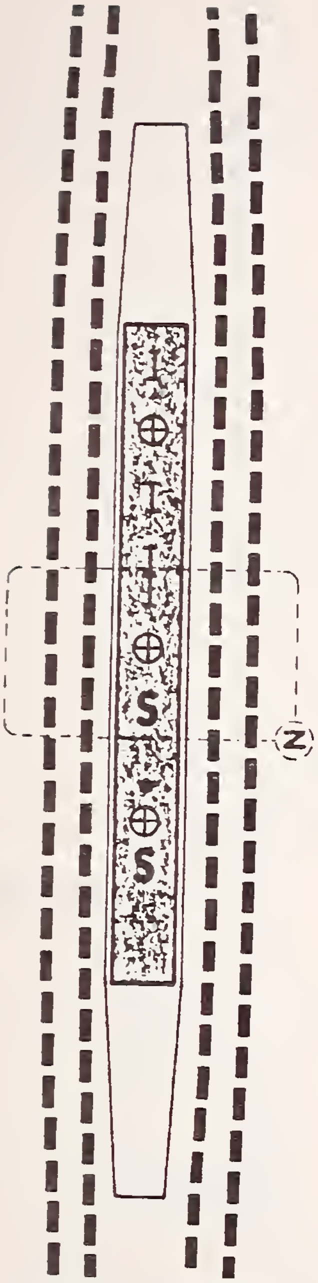


Fig. 5.3 - Dual Center Platform Elevated Steel Station Configuration (Station Type 3)

MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.



OVERALL PLAN

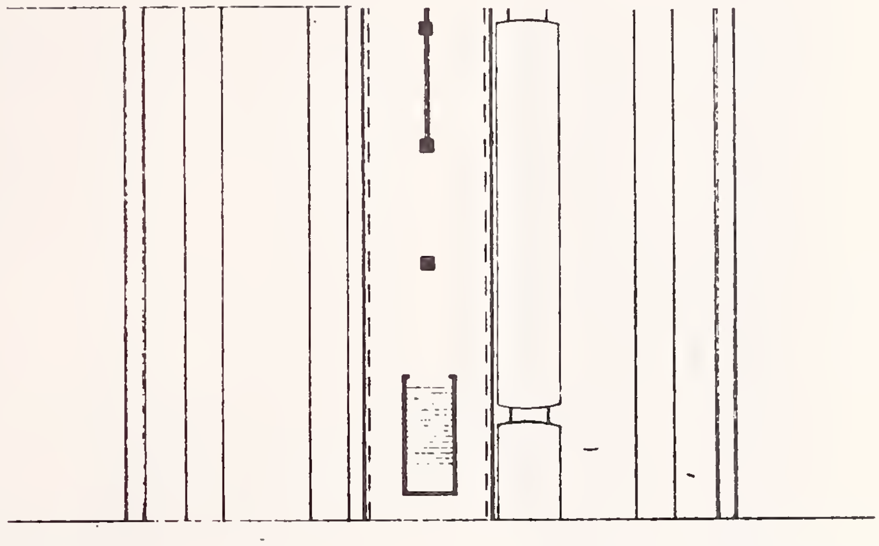
S STAIRS

A AGENT BOX

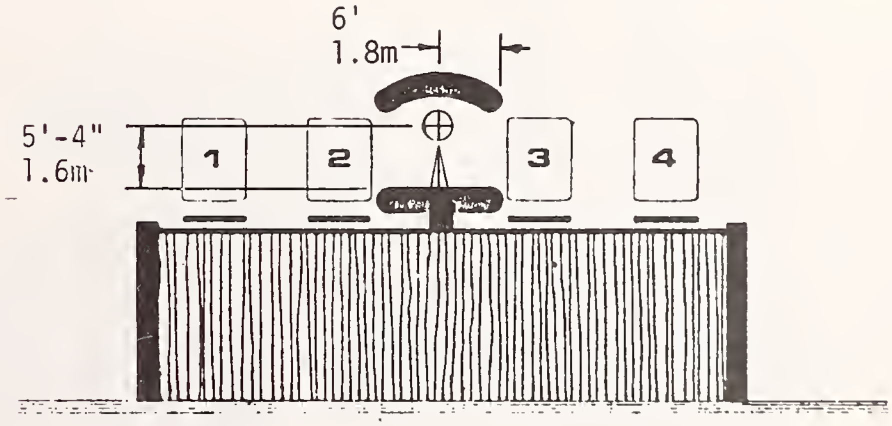
I BARRIER

• BENCH

⊕ MICROPHONE



PLAN SEGMENT Z

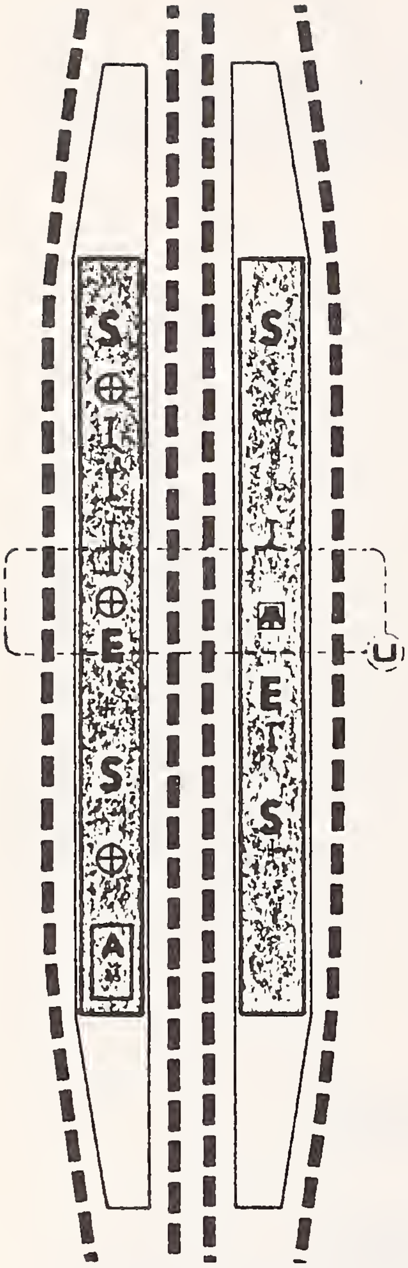


TYP. SECTION

Fig. 5.4 - Center Platform Elevated Embankment Station Configuration (Station Type 4)

MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.



OVERALL PLAN

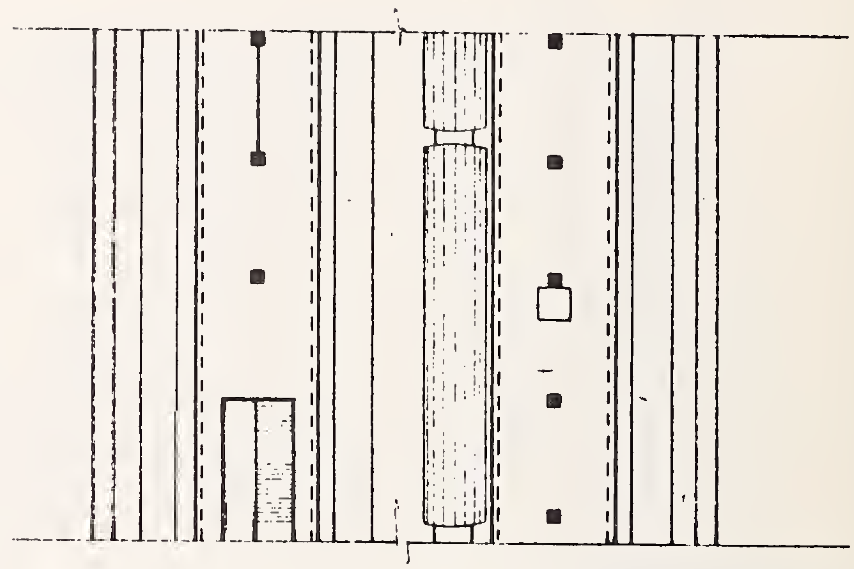
S STAIRS

[A] AGENT BOX

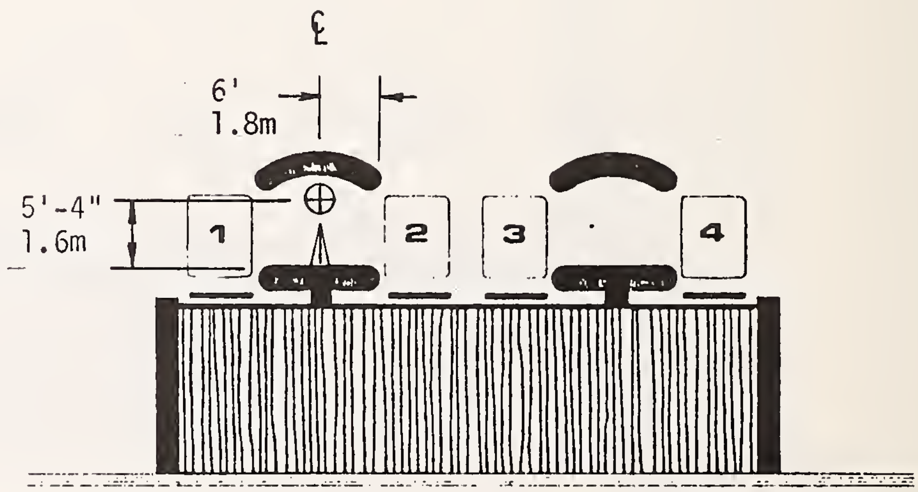
I BARRIER

• BENCH

⊕ MICROPHONE



PLAN SEGMENT U

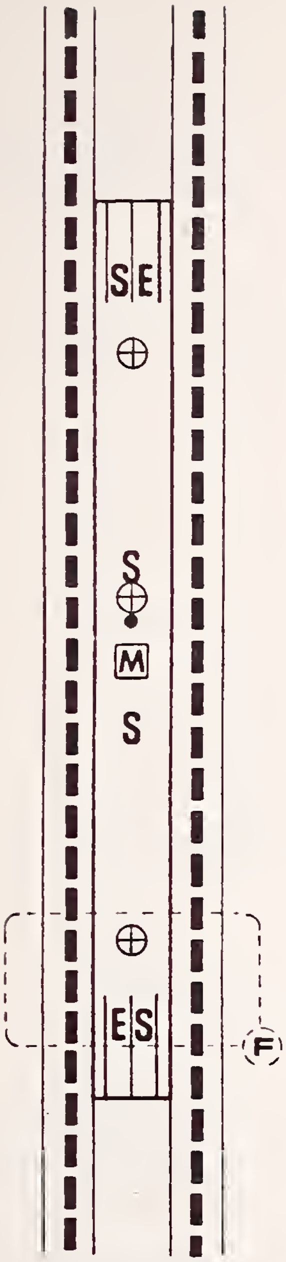


TYP. SECTION

Fig. 5.5 - Dual Center Platform Elevated Embankment Station Configuration (Station Type 5)

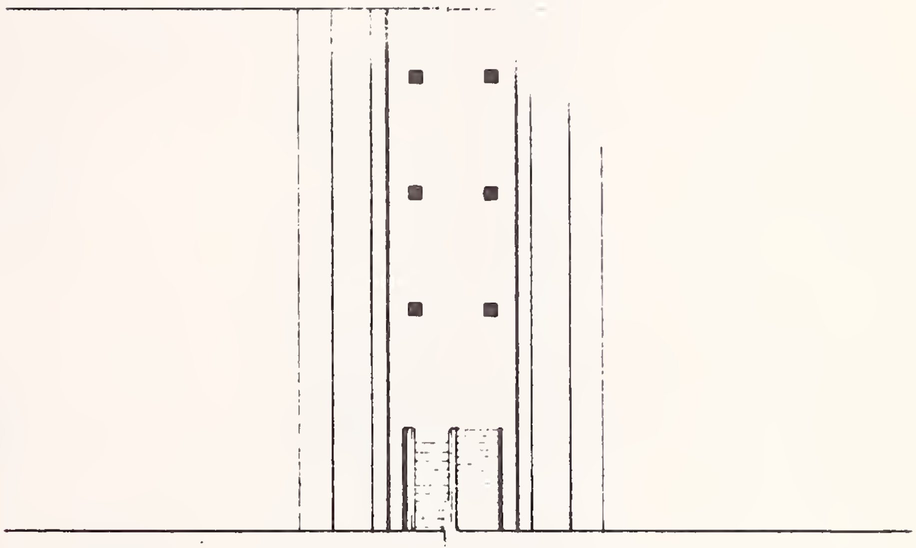
MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT As shown with respect to the platform and at the midpoint of a stationary train.

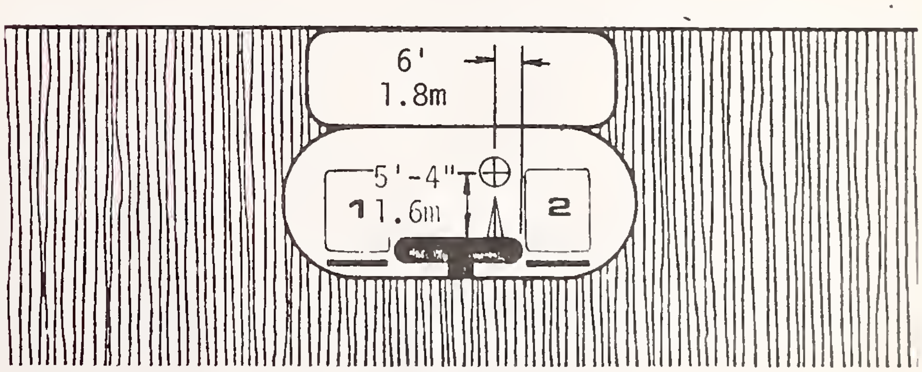


OVERALL PLAN

S STAIRS
A AGENT BOX
I BARRIER
• BENCH
⊕ MICROPHONE



PLAN SEGMENT F

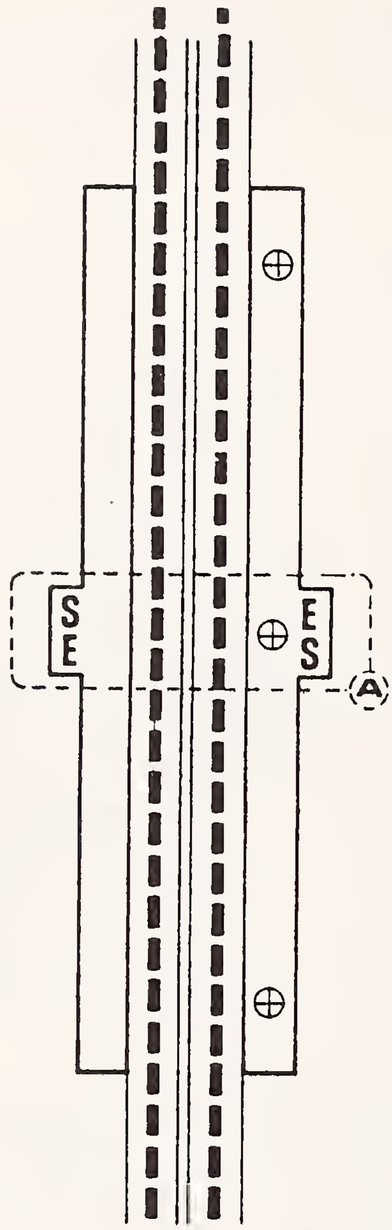


TYP. SECTION

Fig. 5.6 - Center Platform Subway Station Configuration
(Station Type 6)

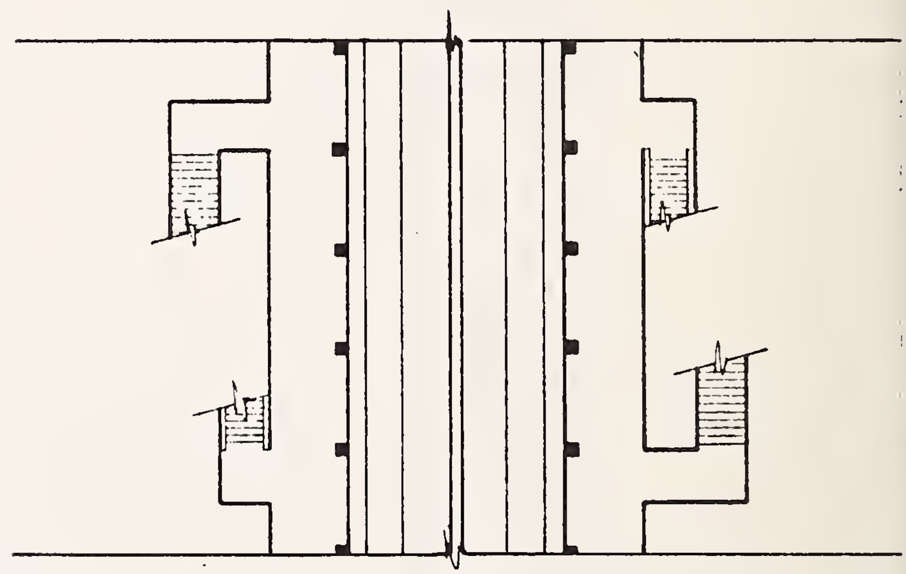
MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.

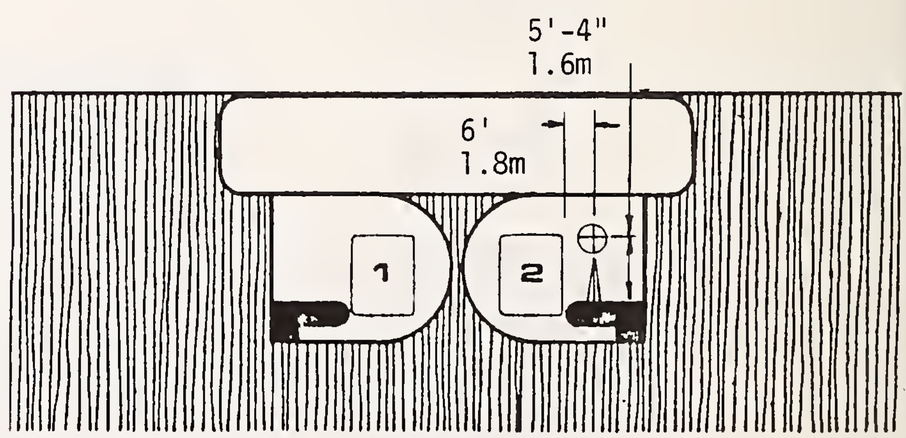


OVERALL PLAN

S STAIRS
[A] AGENT BOX
I BARRIER
• BENCH
⊕ MICROPHONE



PLAN SEGMENT A

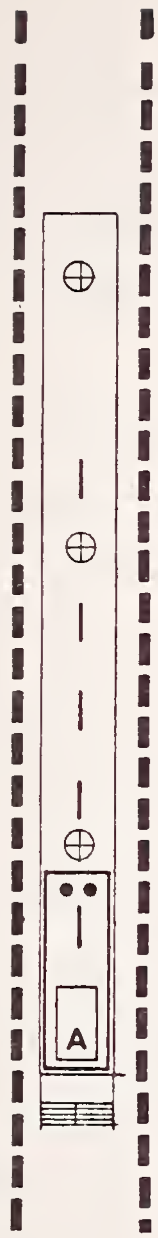


TYP. SECTION

Fig. 5.7 - Side Platform Subway Station Configuration (Station Type 7)

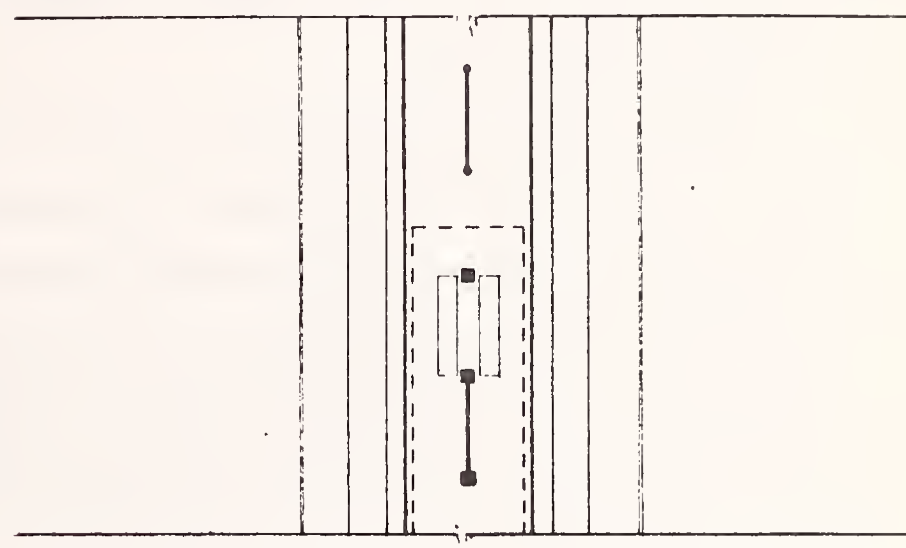
MICROPHONE HEIGHT: 5'-4" (1.6m)

MICROPHONE PLACEMENT: As shown with respect to the platform and at the midpoint of a stationary train.

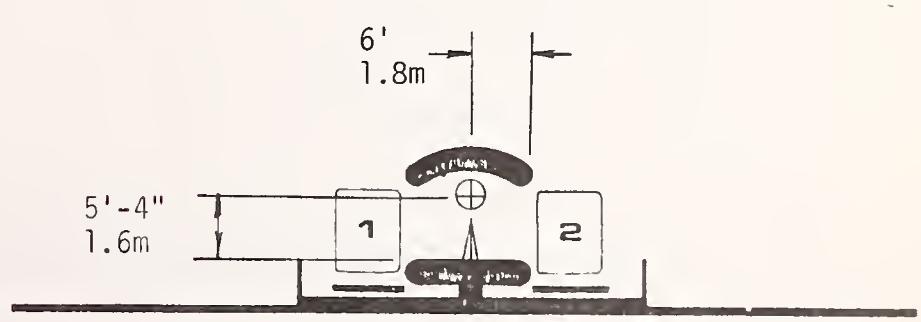


OVERALL PLAN

- **S** STAIRS
- A AGENT BOX
- I BARRIER
- • BENCH
- ⊕ MICROPHONE



PLAN SEGMENT



TYP. SECTION

Fig. 5.8 - Center Platform Median Strip or At-Grade Station Configuration (Station Type 8)

may or may not pass between the tracks that load and unload passengers in the station. Whereas the previous station types are fairly common, Fig. 5.3 shows a special station where dual platforms serve four trains, from one center platform and from two side platforms.

Another common structure type supporting rapid transit stations is an elevated embankment, where concrete retaining walls restrain the soil upon which the station and the track are constructed, as shown in Fig. 5.4. Here a center platform for two-track service is illustrated. Fig. 5.5 shows a similar elevated embankment structure where dual center platforms can serve as many as four tracks.

A typical subway structure using a long center platform is shown in Fig. 5.6, and a similar subway structure with a side platform configuration is shown in Fig. 5.7. Finally, Fig. 5.8 shows a station typical of the type constructed in the median strips of freeways. These stations are all built with a center platform configuration.

Table 5.2 also shows that each of the rail rapid transit stations can be classed into the following three groups, depending on the type of track construction that exists in the station:

1. Welded Rail with Wood Tie
2. Bolted Rail with Wood Tie
3. Welded Rail with Concrete Tie

Such a classification may be used to help determine the influence of track construction on the magnitude of generated noise levels and to choose representative stations in which to make measurements.

5.3 MEASUREMENT LOCATION

Most measurements were made on the center line of the platform, equidistant from the platform edges. However, in side platform stations the microphone was placed either 2m (6 ft-6 in) from the edge of the platform, or 2m (6 ft-6 in) from the nearest reflecting surface if a wall defined the platform edge on the side away from the vehicle. In addition, the microphone was placed so that when the train was stopped in the station to load or unload passengers, the microphone was at the center line of the train. The microphone for all measurements was set at a height of 1.6m (5 ft-4 in). Figs. 5.1 to 5.8 show graphically the location of the microphone in each characteristic type of station where noise measurements were made.

5.4 SELECTION OF CHARACTERISTIC STATIONS

Based on the eight station types defined for the CTA rail rapid transit system and a study of other physical characteristics that exist in each of the 155 stations, the matrix in Table 5.4 was prepared to help evaluate

TABLE 5.4

MATRIX SHOWING CHARACTERISTIC STATIONS OF THE CHICAGO RAIL RAPID TRANSIT SYSTEM

		Structure Type								Foundation Type				Track Type			Station Type				
Station Name	Map Location	El Steel	El Embank	Median	Subway	At-grade	Cut	Embank	El Concrete	Con Ftg	Ballast	Con Tie Bed	El Con/Bal	Weld/Wood	Bolt/Wood	Weld/Con	Center	Side	Dov Cent	Cen & Side	Trip Cent
Oak Park	CON 5					X					X			X			X				
Pulaski	CON 23			X							X			X			X				
Clinton	CON 53				X						X			X			X				
Pulaski	DPK 14	X								X					X		X				
Hoyne	DPK 27	X								X					X			X			
Cermak	DAN 69								X				X		X		X				
Foster	HOW 12							X			X				X		X				
Davis	HOW 14							X			X				X			X			
Howard	HOW 24		X								X				X				X		
Loyola	HOW 32		X								X				X		X				
Argyle	HOW 43		X								X			X			X				
Wilson	HOW 47	X								X					X						X
Clark	HOW 75				X							X		X			X				
Chicago	HOW 78				X							X		X				X			
Irving Park	MIL 9			X							X					X	X				
Belmont	MIL 16				X							X				X	X				
Roosevelt	JAC 48				X							X			X		X				
Kedzie	RAV 4					X					X				X		X				
Francisco	RAV 6					X					X				X		X				
Belmont	RAV 36	X								X					X				X		
Dempster	SKO 1					X					X				X			X			

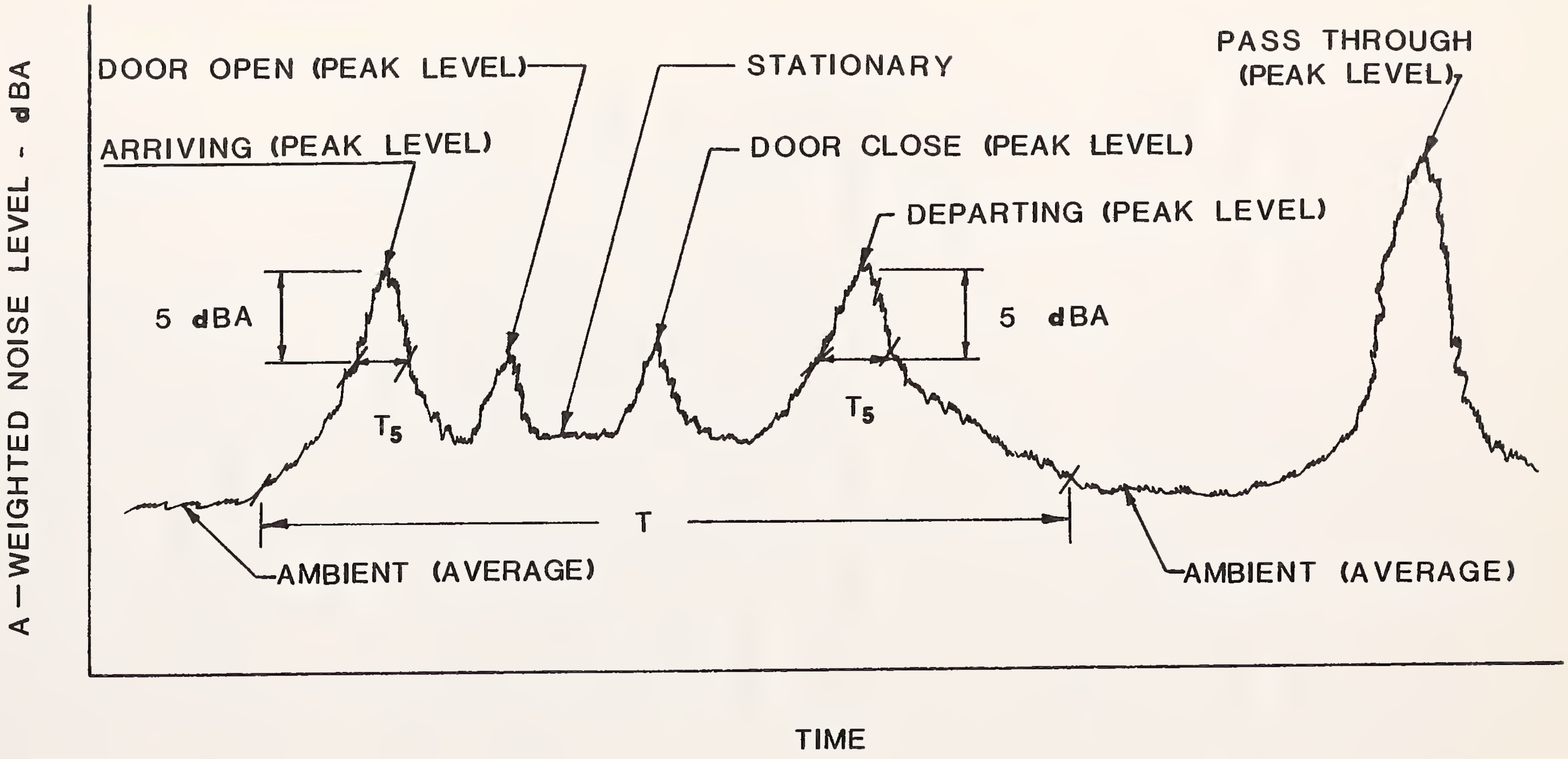
which transit stations best represented the noise climate in the rail rapid transit stations of the Chicago Transit Authority. As shown in Table 5.4, 21 stations were selected to represent the system, and a significant number of noise measurements were made in each of these stations.

In making noise measurements, the measurement team set up equipment in each of these stations and occupied the site for a length of time sufficient to record at least 8 train pass-bys and train stops. This measurement frequency was selected from the results of a statistical study of the noise measured from 40 train arrivals and departures in the Clinton Station before the actual measurement program began. This study showed that a required confidence level of 0.05 for in-station measurements could be achieved from 8 recorded noise measurements.

For each noise measurement, the train type, number of cars, and passenger load was recorded. In addition, for trains that passed through the station without stopping, peak speed values were obtained using the radar unit.

5.5. EVALUATION OF RECORDED NOISE LEVELS

An idealized time history for the noise levels obtained for a train arriving and departing from a typical station is shown in Fig. 5.9. This figure clearly shows several peak noise



(A)

$$L_R = L_{A(Max)} + 10 \text{ LOG } T_5 \qquad L_{eq} = L_R - 10 \text{ LOG } T$$

(B)

Fig. 5.9 Definition of Terms Used to Define (A) Measured In-Station Noise Levels and (B) Noise Objective Functions

levels which are characteristic of transit train operation as it arrives and departs from a station. The form of the data is typical of all noise measurements made in stations. For example, as a train comes into a station, there is a peak representing the maximum arrival noise level. This peak then decreases until there is a small noise peak caused by the doors opening, followed by a plateau level until another peak when the doors close. This is followed by a departing peak level which decreases as the train leaves the station. Between train arrivals ambient in-station noise levels were measured for a significant portion of the in-station measurement time.

A typical record of the A-weighted noise level in a subway station is shown in Fig. 5.10, in which the peak noise levels associated with each phase of train operation (arrival, door open, stationary, door close, depart, pass-through) are evident. In comparison, a third history for in-station noise levels for a median strip station in the center line of a freeway is shown in Fig. 5.11. It can be seen that the ambient noise levels are quite high and that it is quite difficult to discern the train arrival, since a significant peak is not shown on the record. In fact, in many cases the in-station noise levels were lower when trains were standing in the station, because the train acted as a noise barrier, preventing the highway noise from reaching the microphone.

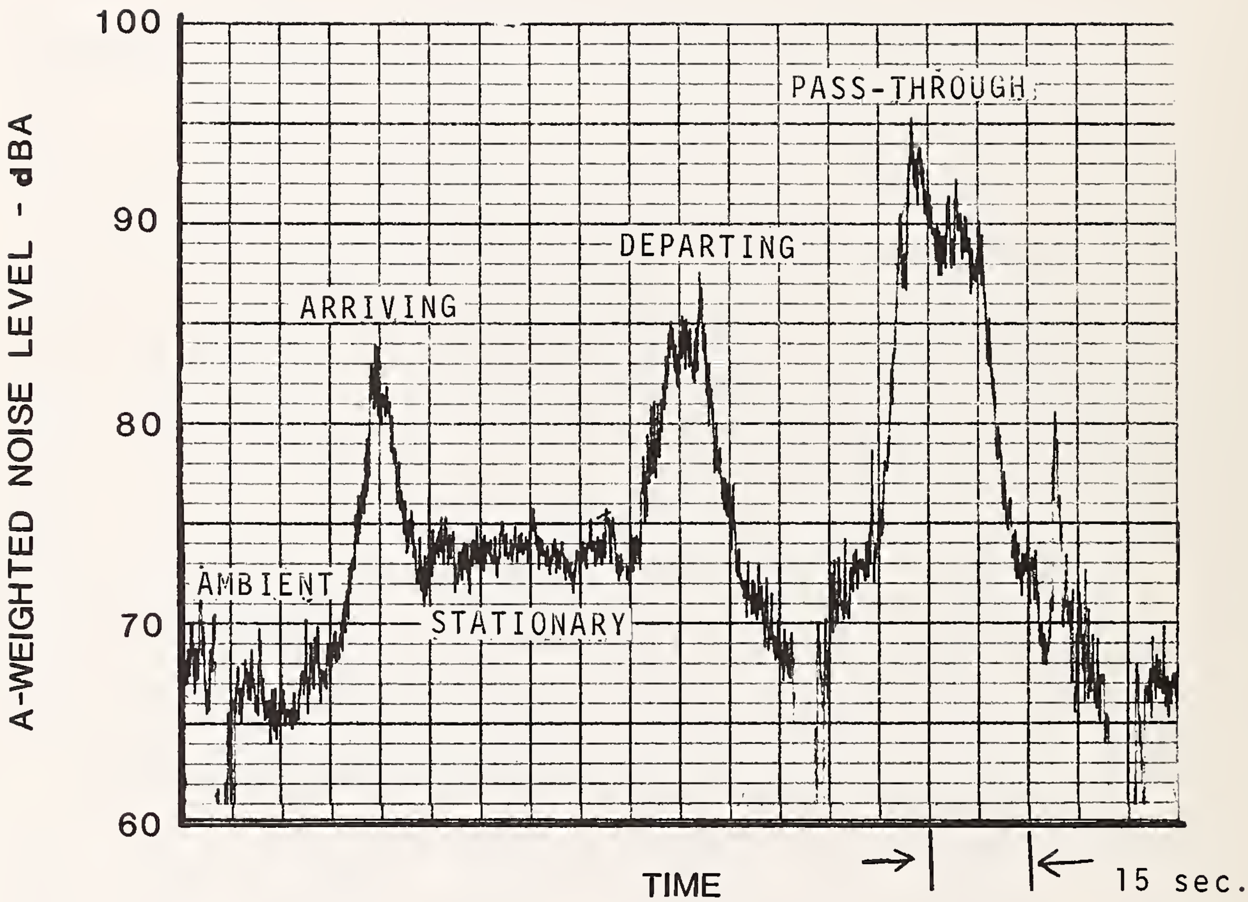


Fig. 5.10 Typical Time History of In-Station Noise Levels for the Jackson Park Service at the Roosevelt Station (Subway)

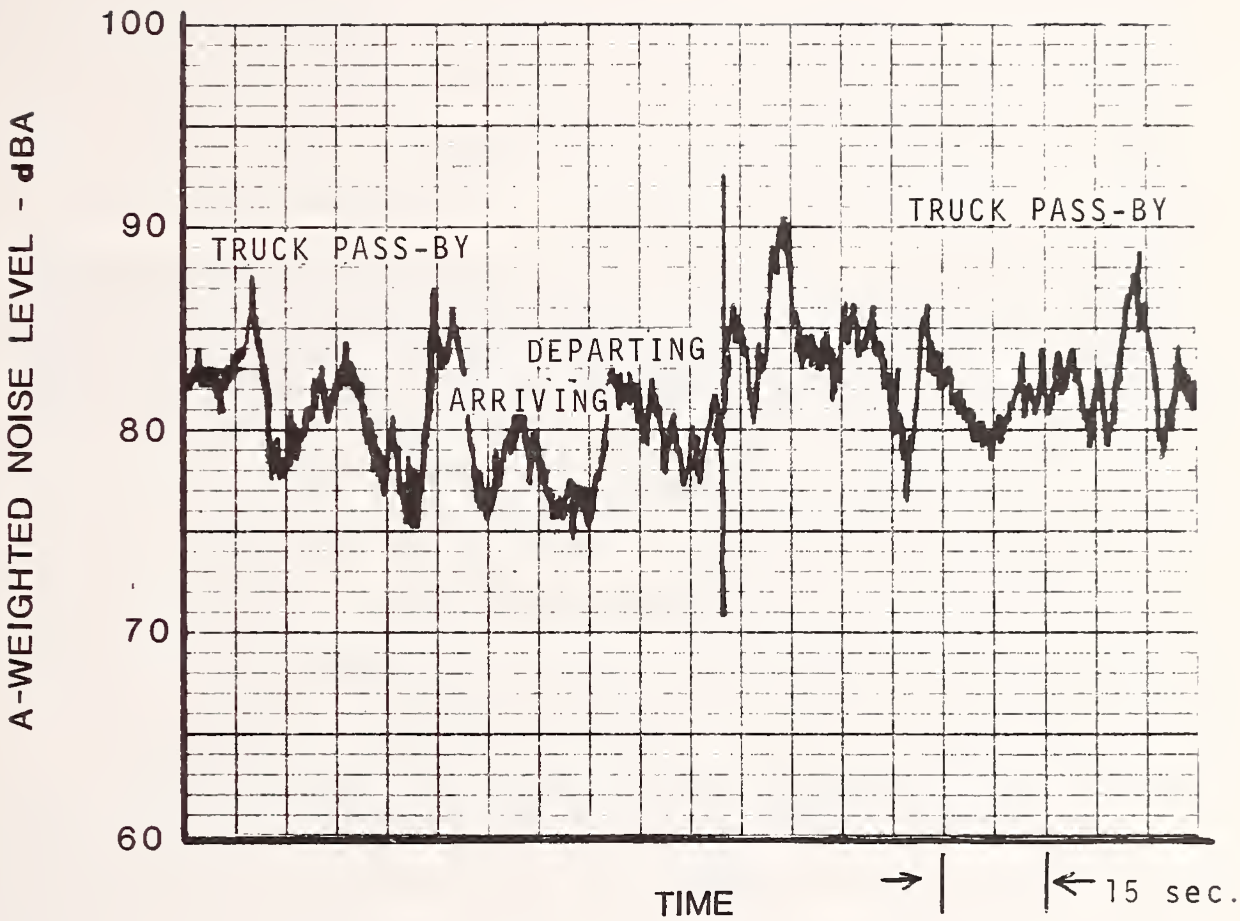


Fig. 5.11 Typical Time History of In-Station Noise Levels for the Congress Service at the Pulaski Station (Median Strip)

From time histories such as those shown in Figs. 5.10 and 5.11, seven significant peak noise levels were noted for each train measurement recorded in every station. These are represented as the maximum A-weighted noise level (in dBA) for entering trains, for opening doors, for stationary trains, for closing doors, and for departing trains. In addition, peak noise levels were determined for trains which passed through stations without stopping. Additional measurements were also analyzed to evaluate ambient noise levels in stations between train arrivals.

A typical plot of in-station A-weighted maximum noise levels is shown on Fig. 5.12 for a station on an elevated steel structure for 2-car trains of 2200 series vehicles. For each noise event measurement (entering, door open, stationary, etc.) a small horizontal dash has been drawn to indicate the maximum.

For the A-weighted noise level for each train measured, the small number to the right of the data points indicates the total number of measurements made for that combination of train type and number of cars. The height of the base extending vertically from the horizontal axis indicates the average maximum A-weighted noise level recorded for all train measurements.

In general, it may be seen that the entering and departing noise levels were approximately equivalent; this same pattern was observed for almost all station types, for all number of cars, and for all train types. Similarly, it may be seen that

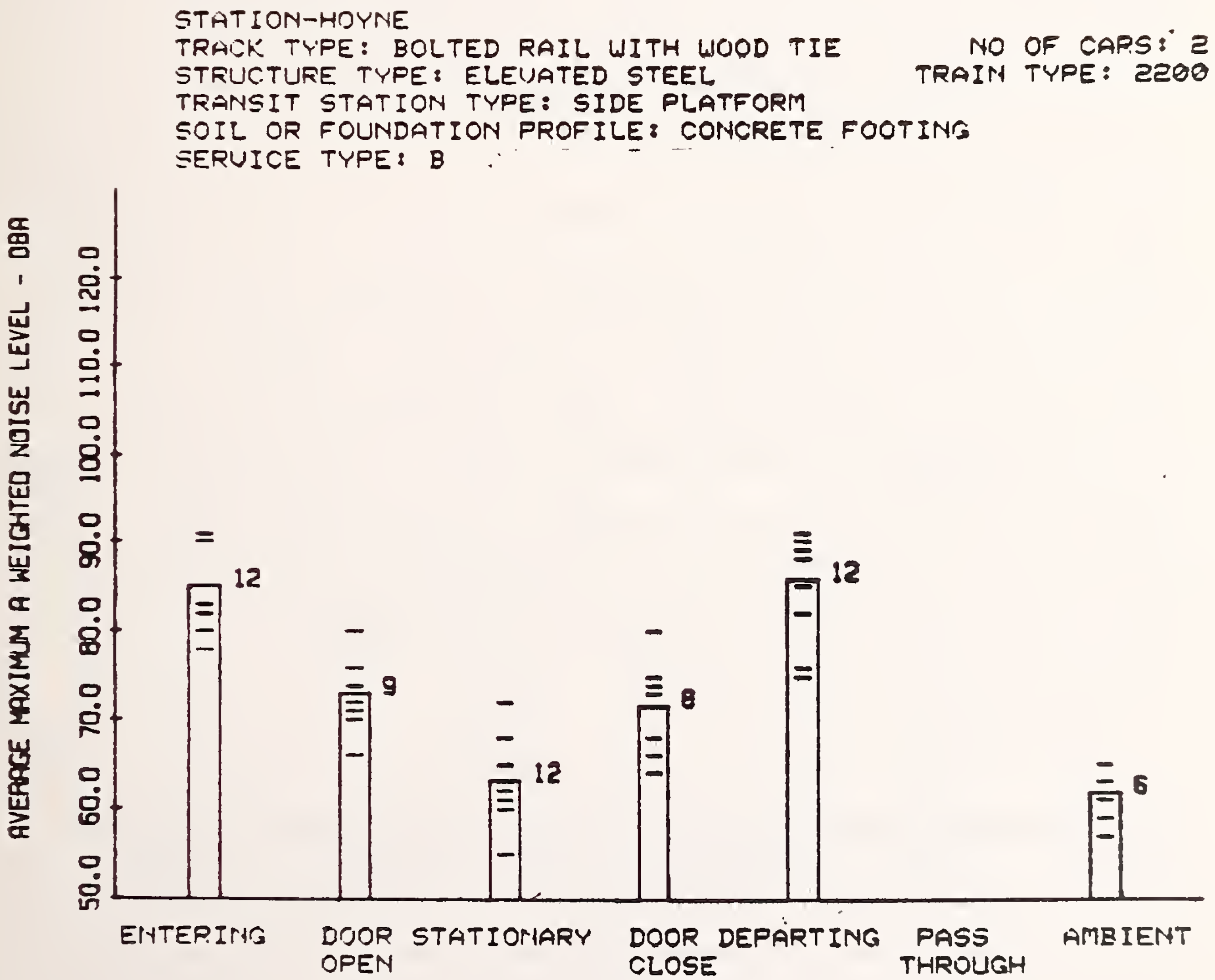


Fig. 5.12 - Average A-Weighted Noise Levels for the Hoyne Elevated Steel Station (2-Car Trains, 2200 Cars)

the door opening and door closing noise levels were approximately equal and slightly lower than the entering and departing noise levels. Finally, it may be seen that a further minimum was achieved for trains standing in the station. The last column shows the ambient noise levels for the station, which in this case were significantly lower than the noise levels measured with the train in the station.

In a similar way, average maximum A-weighted noise levels (indicated by the height of the bar) for a subway station for 2-car, 2200 series vehicles are shown in Fig. 5.13. It may be seen that the form of the noise data is similar to that shown for the elevated steel station in Fig. 5.12. However, this station was an A-type station, where B trains passed through at a reduced speed of approximately 35 mph. The maximum A-weighted noise levels for such pass-throughs are also shown on the figure, where it may be seen that these noise levels are significantly higher than the maximum noise levels for either the entering or departing train conditions.

On the other hand, Fig. 5.14 shows a typical plot of average maximum A-weighted noise levels for a median strip station for a 2-car, 2200 series train. No data points have been associated with the train operation since it can be seen that the ambient noise levels approach the noise levels of the train operation. In fact, it was impossible in many cases to

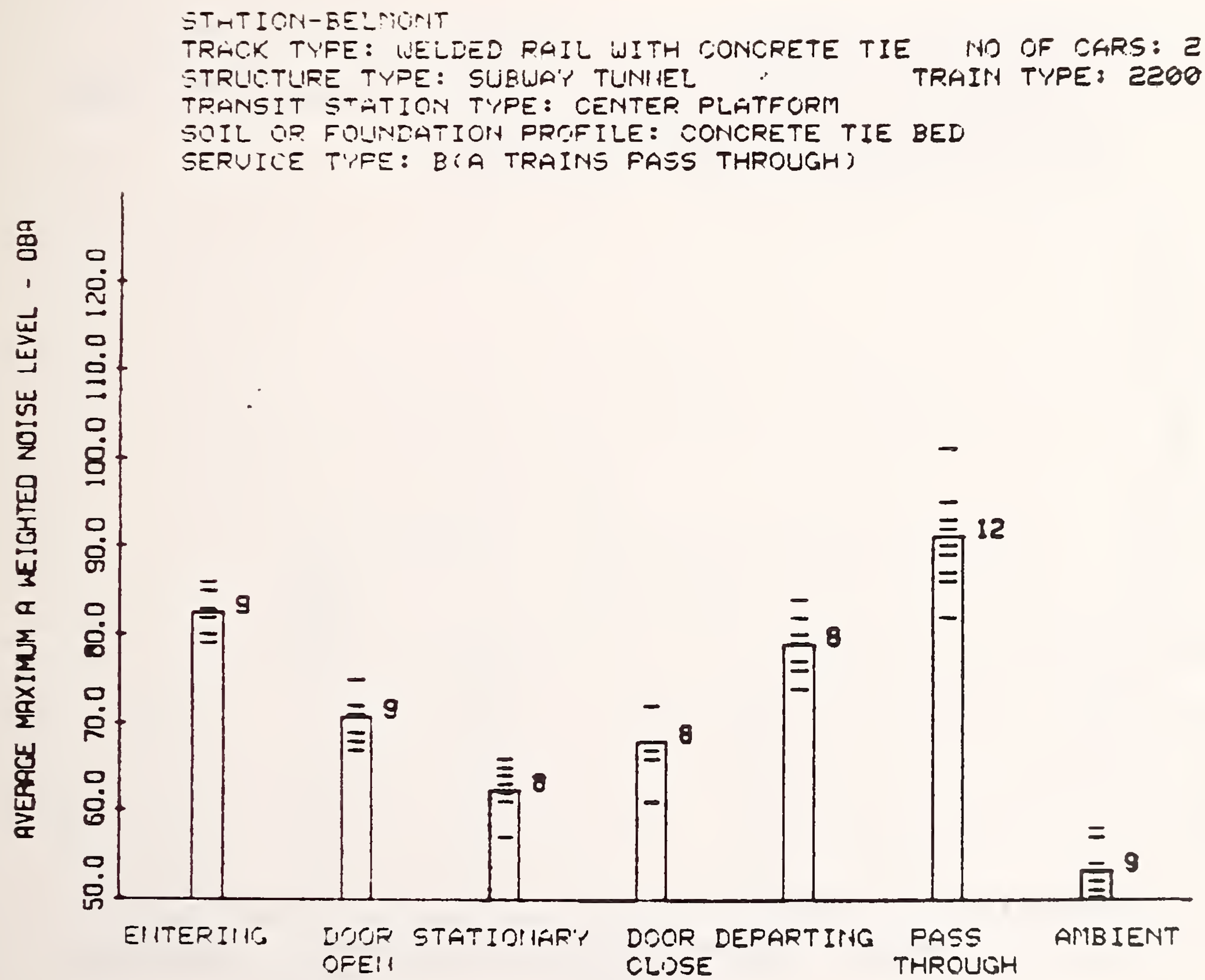


Fig. 5.13 - Average A-Weighted Noise Levels for the Belmont Subway Station (2-Car Trains, 2200 Cars)

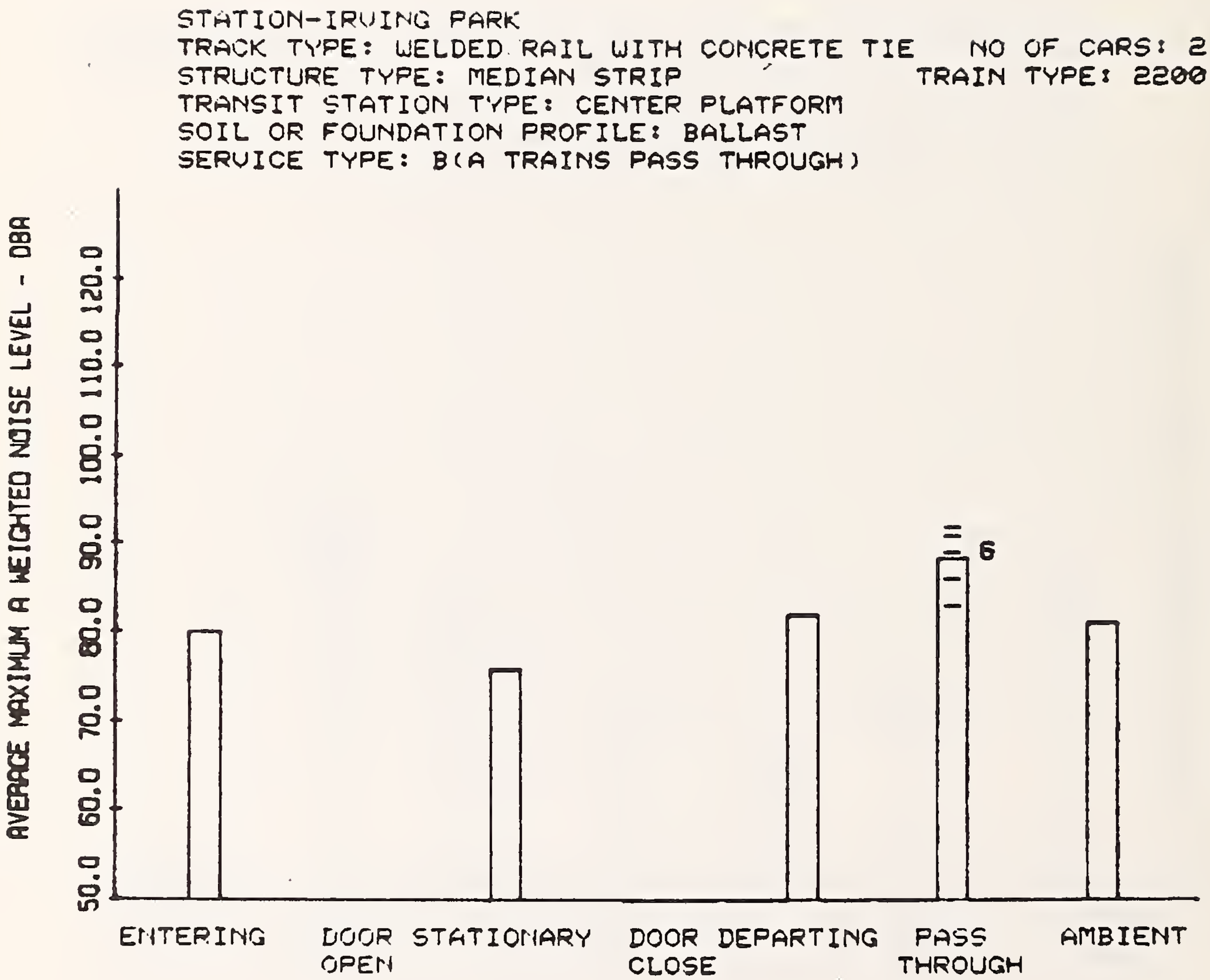


Fig. 5.14 - Average A-Weighted Noise Levels for the Irving Park Median Strip Station (2-Car Trains, 2200 Cars)

tell from the noise time history that a train had actually come into the station because of the high ambient noise levels. However, somewhat higher noise levels than ambient were recorded for trains that pass through the station without stopping as shown on the figure.

Additional bar graphs showing average maximum A-weighted noise levels for each condition of train operation in each measured station are shown in Appendix D . These data have been plotted on separate curves for each station surveyed and for each combination of car type and number of cars.

5.6 STATION, VEHICLE, AND OPERATING CHARACTERISTICS THAT INFLUENCE IN-STATION NOISE

The data in Appendix E has been summarized in Fig. 5.15 to show the effect of car type, number of cars, and structure type on measured noise levels. For in-station noise measurements in general, it was found that the type of car did not significantly influence recorded noise levels. Each data point represents between six and eight measurements. For example, Fig. 5.15 shows that noise levels in an elevated concrete station were approximately equivalent for either 2200 series cars or 6000 series cars. In addition, very little difference was found for different numbers of cars for the same series of trains, which is also shown on the figure, except in subway stations, where 4- and 8-car trains are noisier than 2-car trains. While somewhat higher

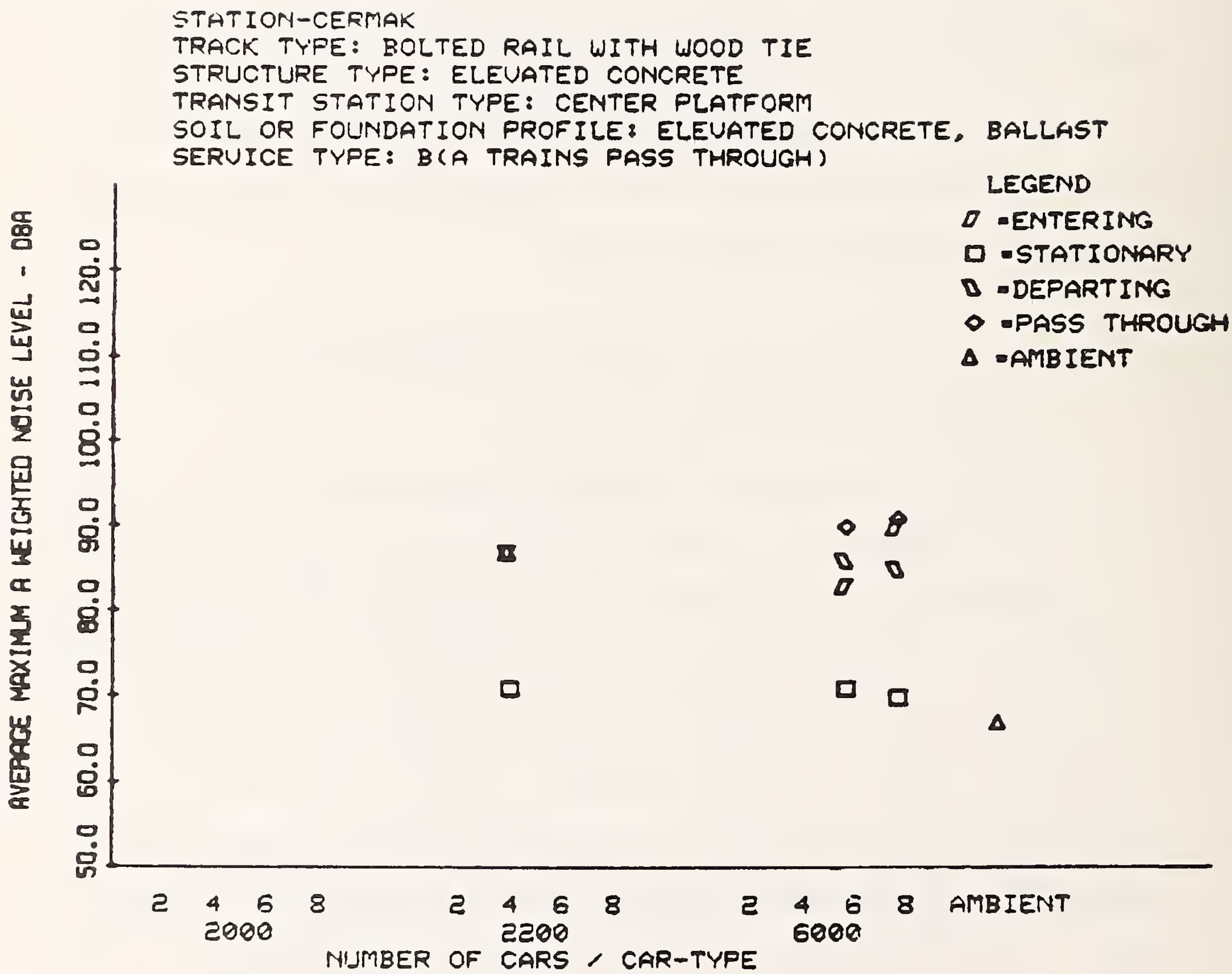


Fig. 5.15 - Effect of Car Type and Number of Cars on In-Station Noise Levels (Elevated Concrete Station)

noise levels were recorded for trains that passed through without stopping, the general trend, except in subway stations, was for noise levels not to be affected by either the type of vehicle or number of vehicles in the train. This conclusion is confirmed by additional data summaries shown in Appendix E .

The data in Appendix E also show that approximately the same noise levels were recorded for arriving and departing trains for any train type and any number of cars. Moreover, it is clear from the data that the noise levels for trains passing through the station are a little bit higher than for the entering or departing trains, while significantly lower levels were always measured for stationary trains. The lowest noise levels of all were measured for the ambient conditions in the stations, except as noted for stations in highway medians.

The effects of station structure type on recorded noise levels is shown on Figs. 5.16 to 5.18 for 6000 series trains of 2, 4 and 8 cars, respectively.

For example, Fig. 5.16 shows noise levels in stations on elevated steel structures, on median strips, in subway tunnels and on embankments for 2-car, 6000 series trains entering, departing, standing and passing through stations, for 6 to 8 pass-bys. The figure shows that the highest noise levels are generated in median strip stations and lowest values are generated in embankment stations. However, the total difference

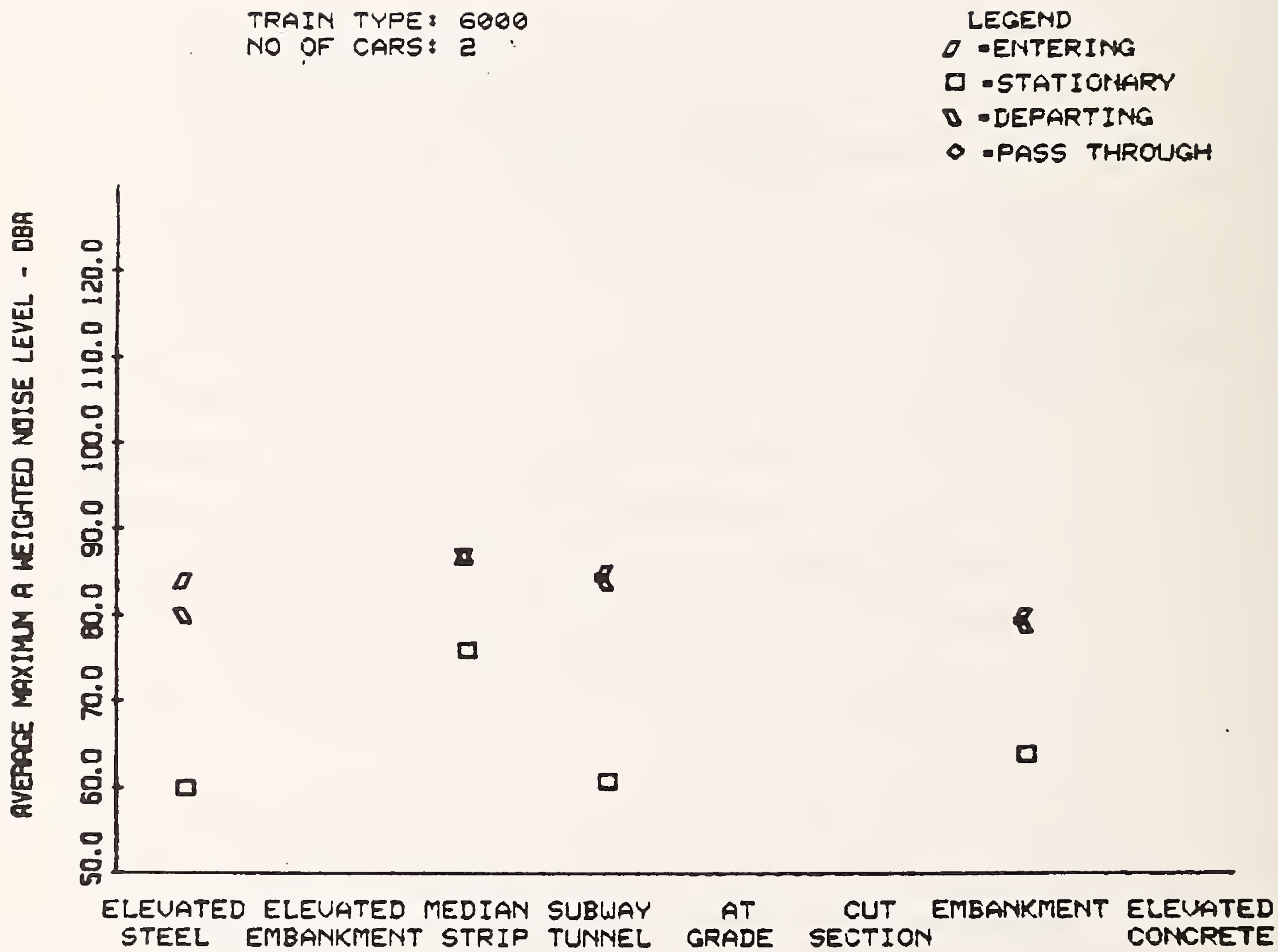


Fig. 5.16 - Effect of Structure Type on In-Station Noise Levels (2-Car Trains, 6000 Series)

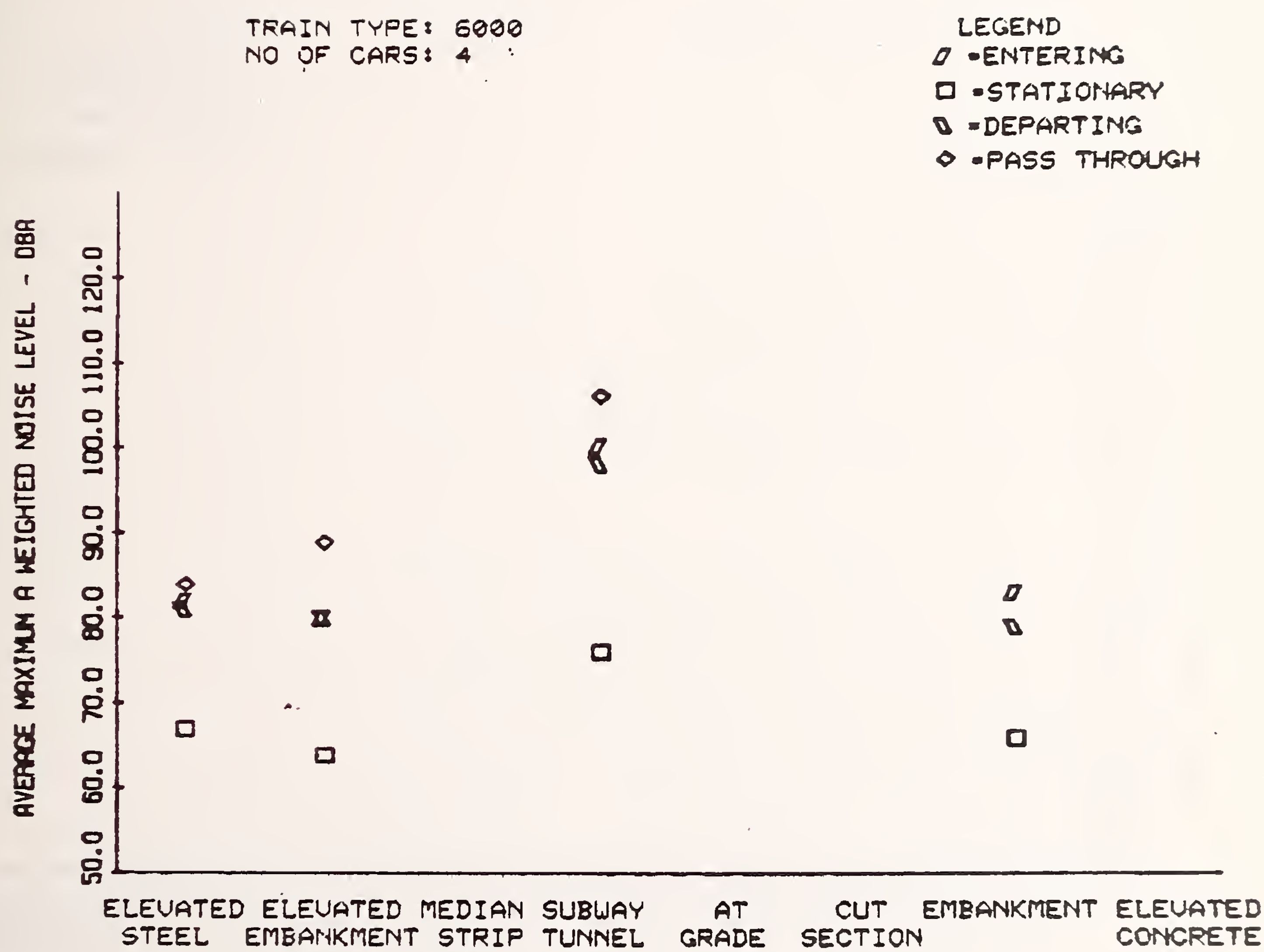


Fig. 5.17 - Effect of Structure Type on In-Station Noise Levels (4-Car Trains, 6000 Series)

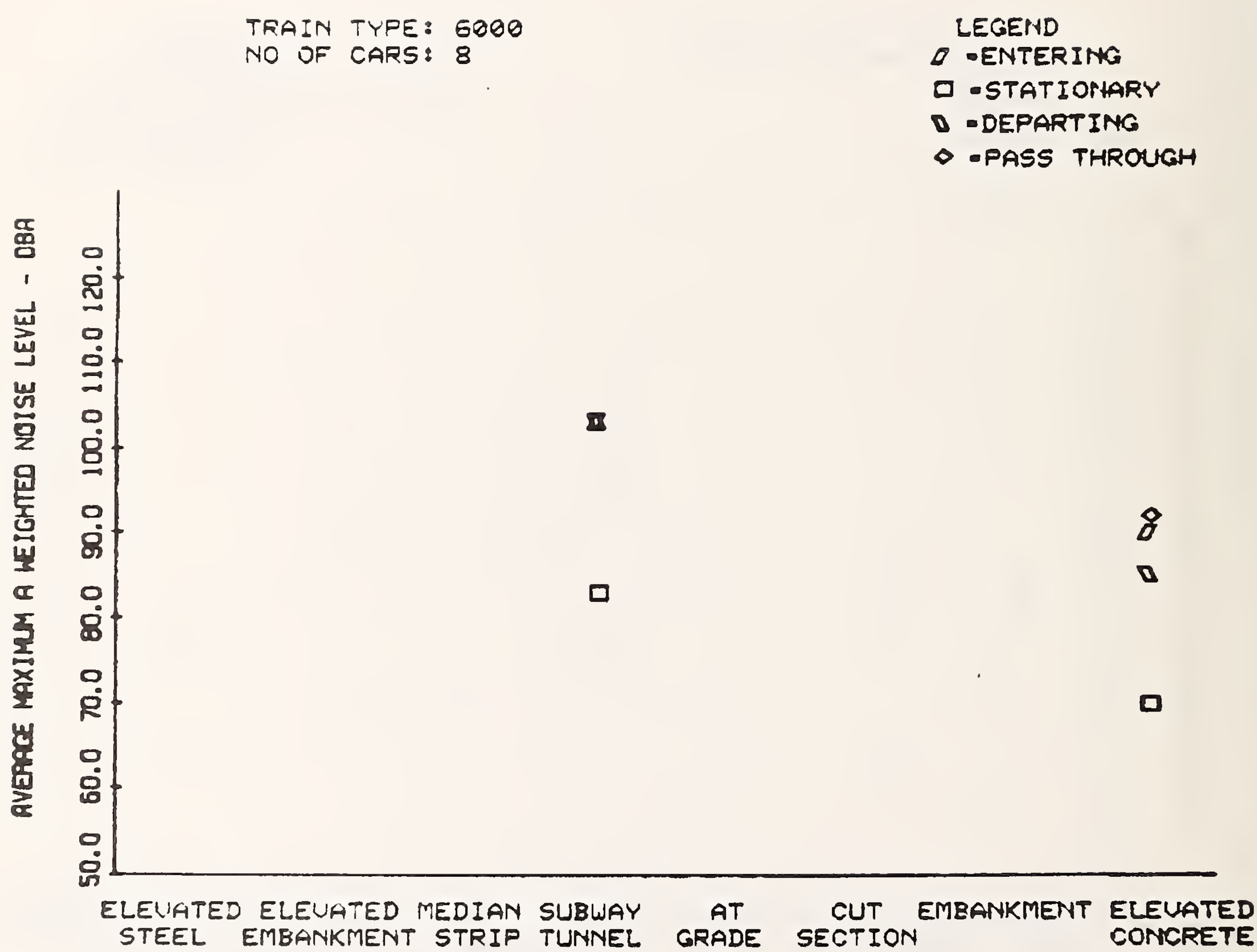


Fig. 5.18 - Effect of Structure Type on In-Station Noise Levels (8-Car Trains, 6000 Series)

is not large. On the other hand, Figs. 5.17 and 5.18, showing noise levels for 4-car, 6000 series trains and 8-car, 6000 series trains, indicates that longer trains are noisier in subway stations and that noise levels can exceed 100 dBA. A complete set of data showing the effects of structure type on in-station noise levels by train types is included in Appendix F.

5.7 SUMMARY OF IN-STATION NOISE LEVELS

As discussed previously, to evaluate noise levels in all rail rapid transit stations it is necessary to define stations that are acoustically similar to the surveyed stations. This was done using the data management system and the rail rapid transit physical attributes survey described in Chapter 3 and Appendix A. The results tabulated in Table 5.5 show how noise levels in each of the 21 measured stations can be extended to the 155 stations of the system.

To develop a picture of the acoustic climate in all CTA stations, the maximum noise levels for either entering or departing trains, taken as the average for at least 8 train measurements in each of the 21 measurement stations, were related to the remaining stations using Table 5.5. The resulting information, tabulated in Table 5.6, shows the number of stations where the maximum noise levels (excluding pass-throughs) were found to be within specified bands. It may be seen that for the majority of the stations maximum noise levels are between 85 and 90 dBA. For some stations noise levels go up to 95 to 100 dBA but in only one station was an average noise level of 100 dBA exceeded.

TABLE 5.5

SUMMARY OF STATIONS WHERE NOISE LEVELS ARE EQUIVALENT

Station Name	Map Location	Number of Acoustically Similar Stations	Percent of Total Stations
Oak Park	CON 5	5	3.2
Pulaski (Congress)	CON 23	9	5.8
Clinton	CON 53	1	0.6
Pulaski (Douglas Park)	DPK 14	8	5.2
Hoyne	DPK 27	60	38.7
Cermak	DAN 69	1	0.6
Foster	HOW 12	5	3.2
Davis	HOW 14	3	1.9
Howard	HOW 24	1	0.6
Loyola	HOW 32	2	1.3
Argyle	HOW 43	11	7.1
Wilson	HOW 47	1	0.6
Clark	HOW 75	13	8.4
Chicago	HOW 78	3	1.9
Irving Park	MIL 9	12	7.7
Belmont (Milwaukee)	MIL 16	2	1.3
Roosevelt	JAC 48	1	0.6
Kedzie	RAV 4	2	1.3
Francisco	RAV 6	8	5.2
Belmont (Ravenswood)	RAV 36	5	3.2
Dempster	SKO 1	2	1.3
		TOTAL 155	100

TABLE 5.6

SUMMARY OF IN-STATION AVERAGE PEAK
ENTERING OR DEPARTING NOISE LEVELS

Noise Levels in DBA *	Number of Transit Stations in the Range
50 - 55	0
55 - 60	0
60 - 65	0
65 - 70	0
70 - 75	0
75 - 80	21
80 - 85	31
85 - 90	83
90 - 95	0
95 - 100	16
100 - 105	1
105 - 110	0
110 - 115	0
115 - 120	0
TOTAL	152

*Average entering or departing noise level.
Pass-through noise levels not included.

No measurements were made for stations SKO 1, RAV 1, and DPK 1 because trains enter and depart the station so slowly, i.e. no noise at end of line.

6. WAYSIDE NOISE MEASUREMENTS

6.1 INTRODUCTION

Wayside noise measurements were made to evaluate rail rapid transit noise levels transmitted to the wayside community. For these measurements, microphones were placed adjacent to various sections of the rail rapid transit system, and noise levels were recorded for train pass-bys. These recordings were later analyzed in the laboratory to evaluate the magnitude of noise generated and its duration.

The following pages describe measurement locations selected to represent a picture of the entire noise climate along the right-of-way of the Chicago Transit Authority (CTA) rail rapid transit system. The chapter describes the measurement procedures used for these wayside measurements and presents values of measured noise levels. The chapter goes on to describe the influence of car type, number of cars, train speed, and structure type on measured noise levels along the right-of-way. Finally, a summary is presented showing noise levels along the entire wayside right-of-way of the Chicago Transit Authority as a function of distance to the nearest affected wayside structure.

6.2 MEASUREMENT LOCATIONS

In-car and in-station noise measurements indicated that three rail rapid transit physical characteristics were most responsible for the generation of noise along the wayside: 1) structure type, 2) track type, and 3) track geometry. Therefore, the data management system was used to find all combinations of these

physical characteristics along the transit right-of-way. This resulted in the selection of twenty typical measurement sites to represent the entire wayside noise climate for the CTA system. Table 6.1 shows the physical characteristics of each of these measurement locations and Figure 6.1 locates these measurement sites on a schematic representation of the CTA rail rapid transit system.

6.3 MEASUREMENT PROCEDURES

At each measurement site two microphones placed at varying distances from the right-of-way were used simultaneously to record train pass-by noise levels. Each microphone was placed at a height of 5 ft. 0 in. (1.5 meters) above the ground surface. The first measurements were made with the first channel microphone placed 15 ft. from the centerline of the measurement track and the second microphone placed 25 ft. from the centerline of the measurement track. The microphones were then moved to locations 50 ft., 75 ft. and 100 ft. from the measurement track, as described in subsequent paragraphs. Schematic representations of microphone placement locations alongside each rapid transit structure type are shown in Figs. 6.2 to 6.7.

The radar unit was used to record train peak pass-by speed for all measurements. The receiving antenna was placed 15 ft. from the track, pointing in the direction of train travel.

Calibration procedures follow those described in Chapter 2. A calibration signal of 1000 Hz tone at 114 dB was recorded on each channel at the beginning and end of each measurement series at each site.

TABLE 6.1

MATRIX REPRESENTATION OF WAYSIDE MEASUREMENT LOCATIONS AND ASSOCIATED PHYSICAL CHARACTERISTICS

	STRUCTURE TYPE								TRACK TYPE			TRACK GEOMETRY		
	el. steel	el. embank.	median	subway	at-grade	cut section	embankment	el. concrete	weld/wood	bolt/wood	weld/concr.	straight	curved	tight radius
CON 10					X				X			X		
12					X				X				X	
13						X				X			X	
33			X						X			X		
DAN 71								X		X				X
72								X		X		X		
DPK 28	X									X		X		
29	X									X				X
HOW 21							X			X		X		
22							X			X			X	
27		X								X			X	
LAK 10		X							X			X		
11		X							X				X	
MIL 21						X				X		X		
RAV 2					X					X				X
5					X					X		X		
7					X					X			X	
11		X								X		X		
39	X									X			X	
SKO 6								X		X			X	

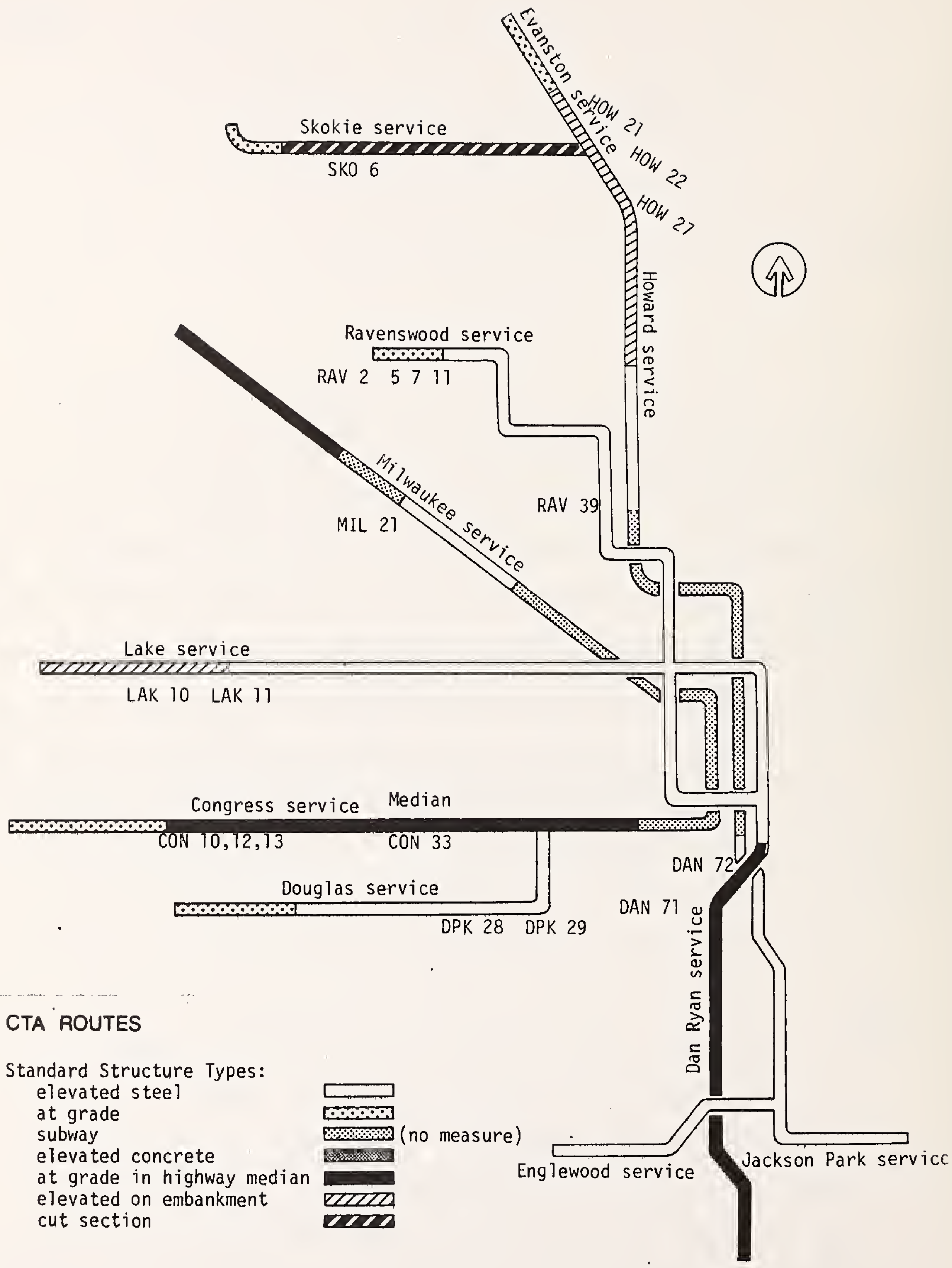


Figure 6.1 Location of Wayside Measurement Locations

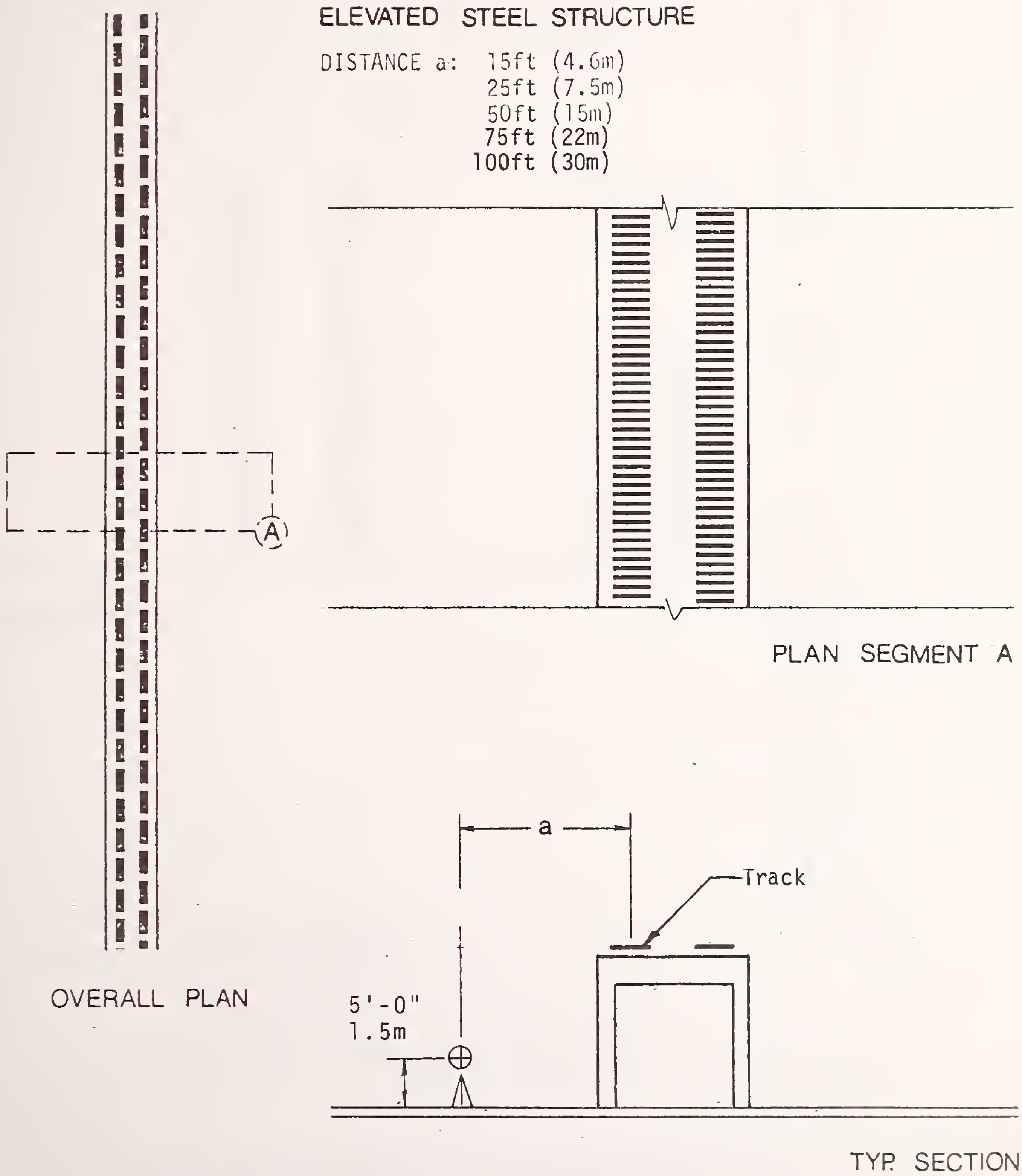


Fig. 6.2 Wayside Measurement Location Adjacent to Elevated Steel Structures

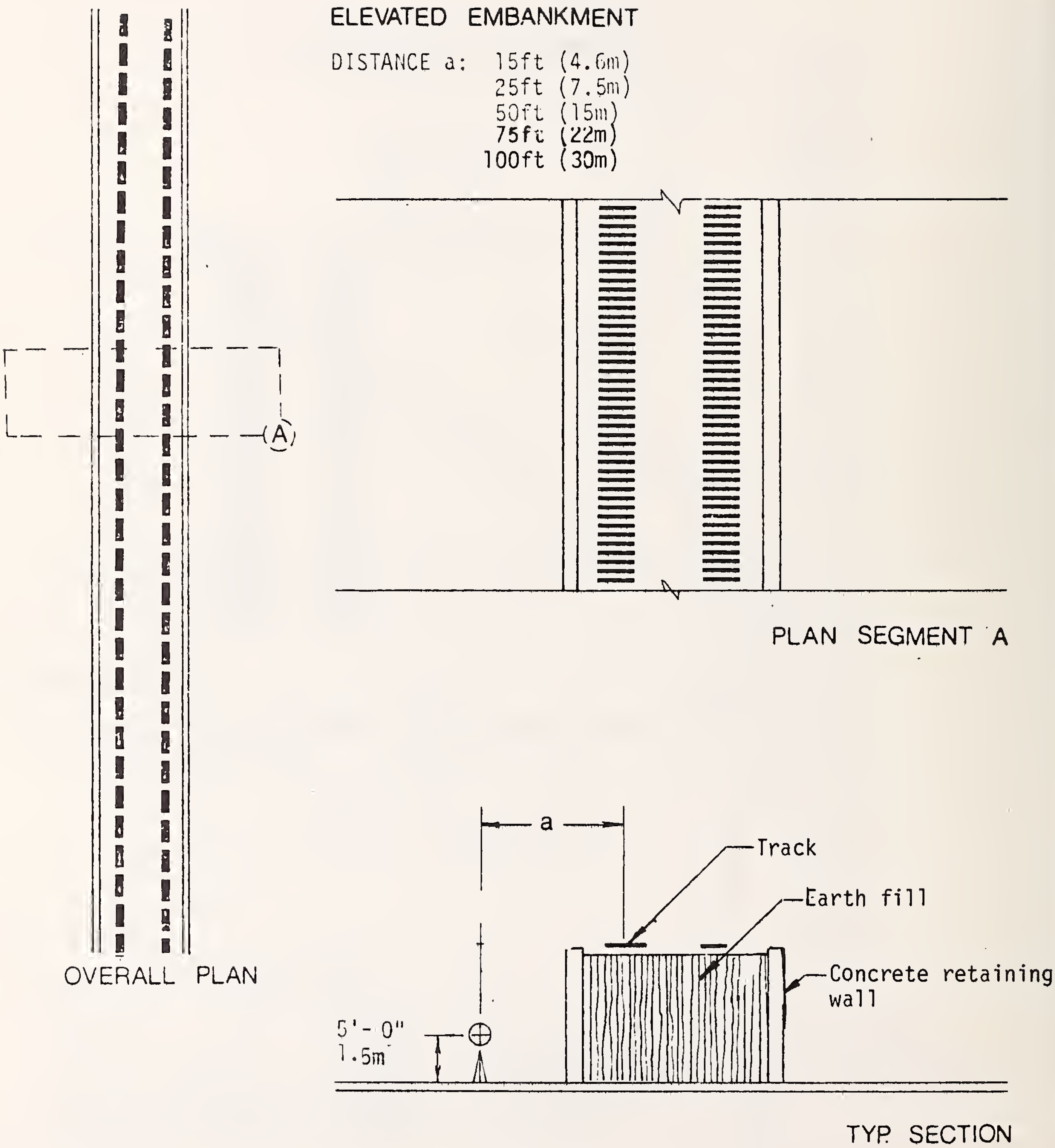


Fig. 6.3 Wayside Measurement Location Adjacent to Elevated Embankment Structures

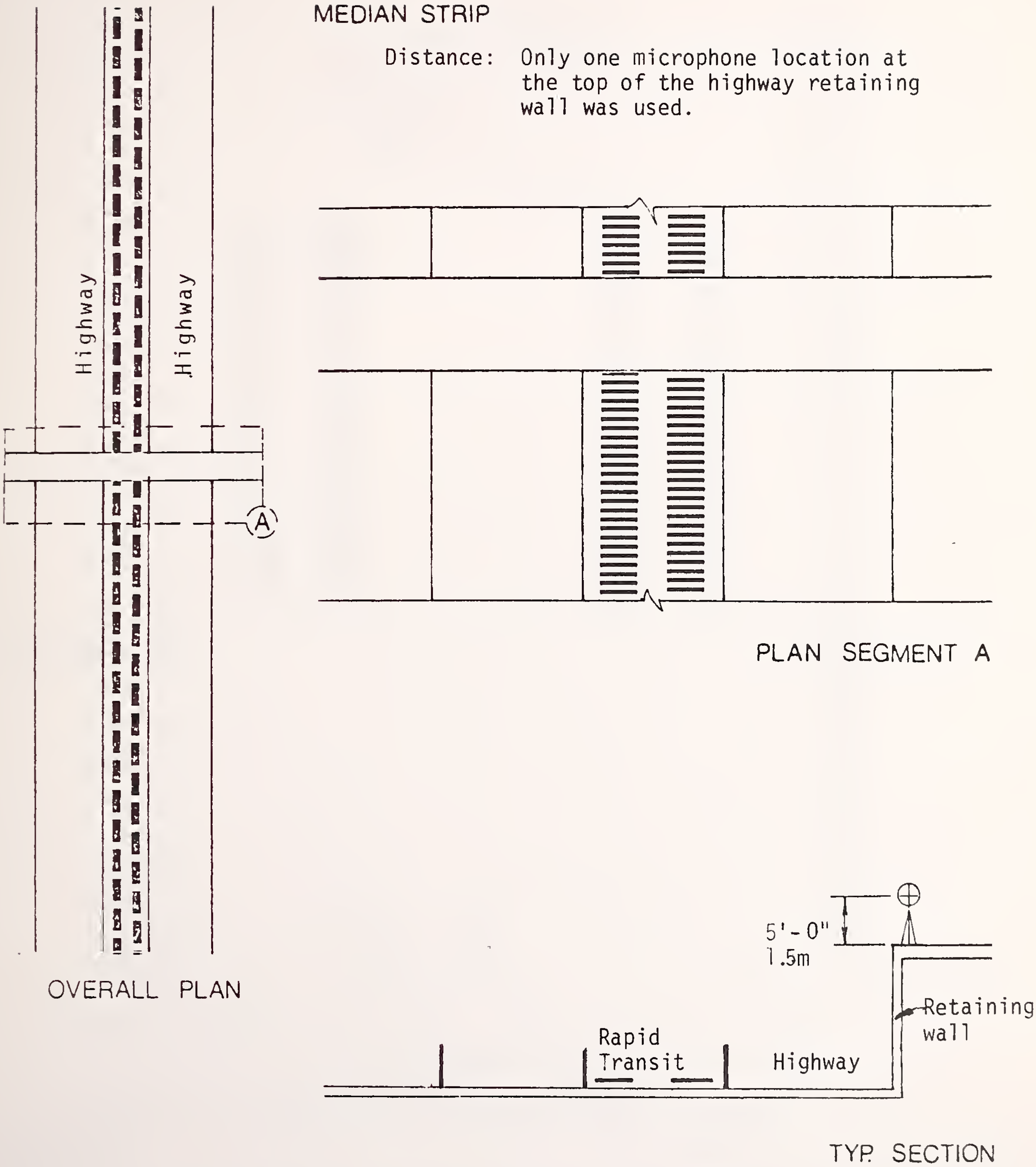


Fig. 6.4 Wayside Measurement Location Adjacent to Median Strip

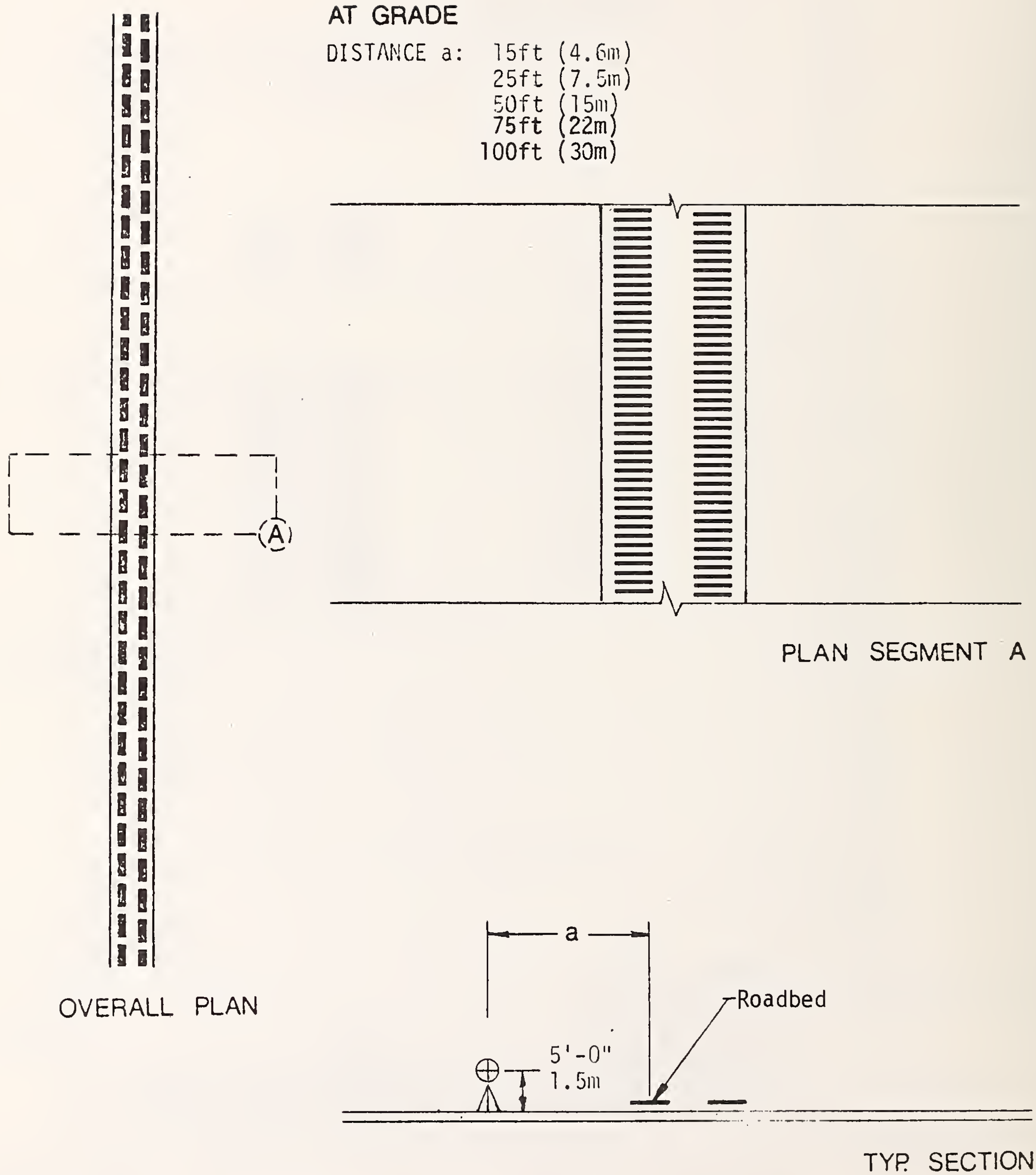


Fig. 6.5 Wayside Measurement Location Adjacent to At-Grade Structures

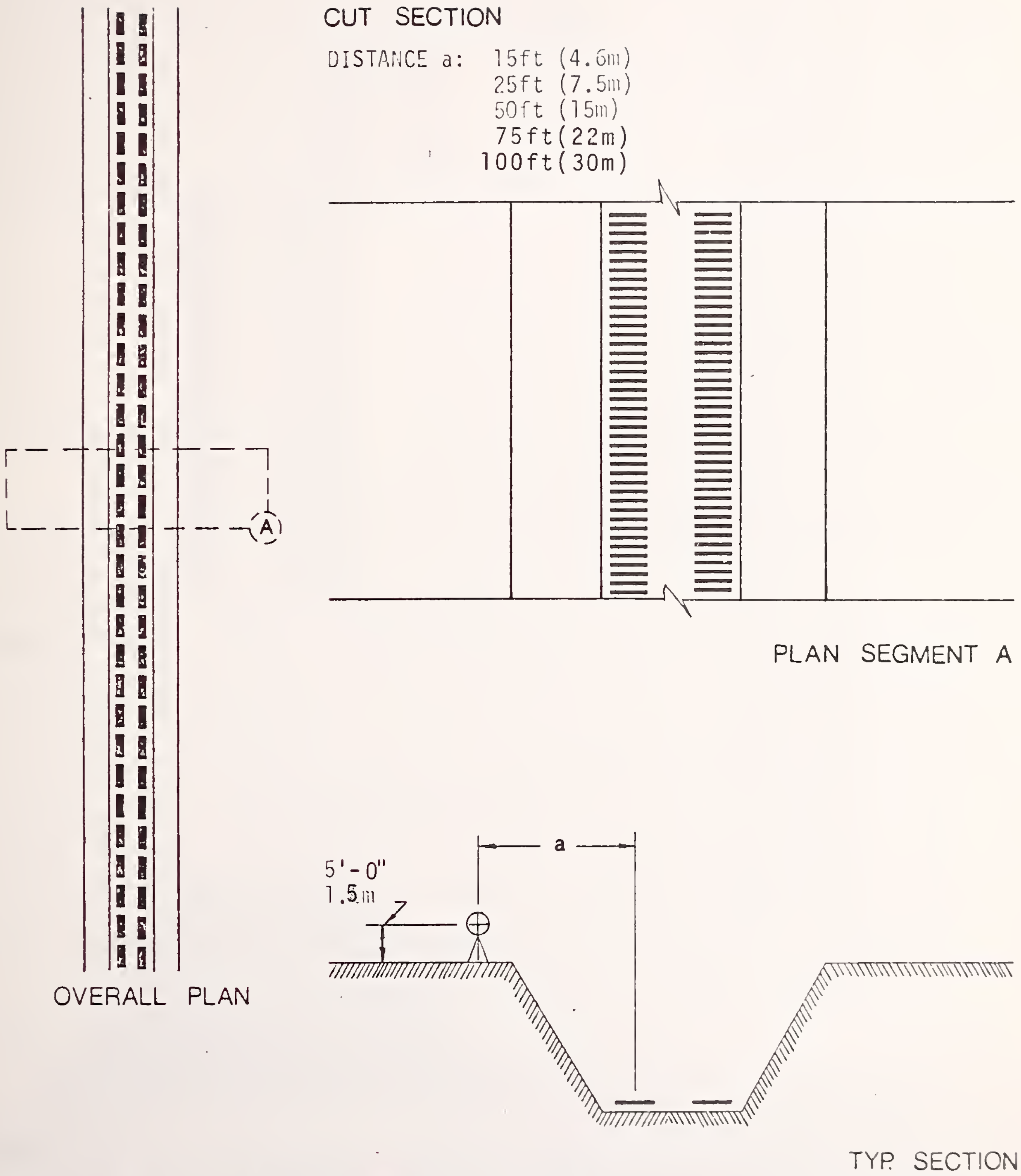


Fig. 6.6 Wayside Measurement Location Adjacent to Cut Sections

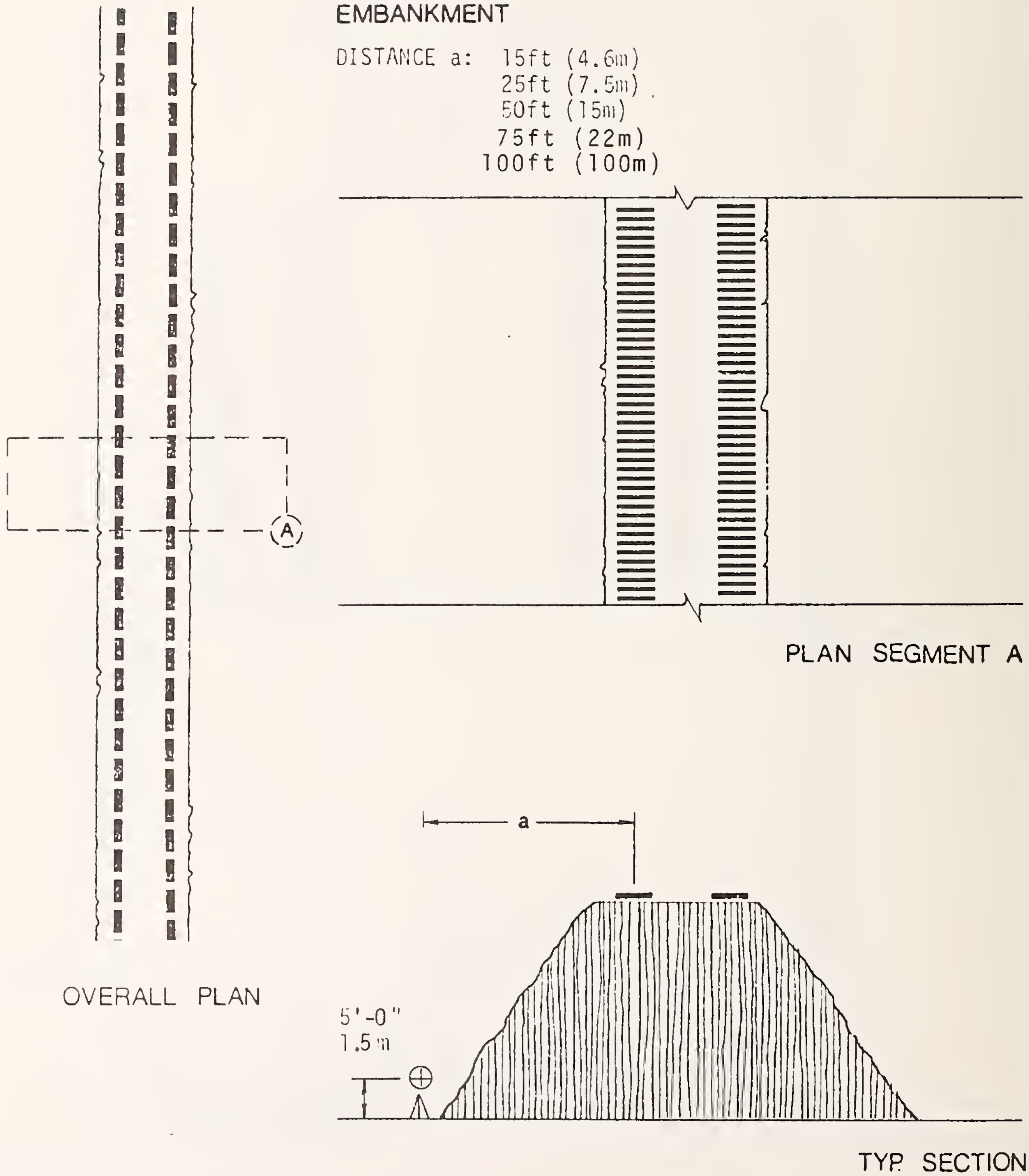


Fig. 6.7 Wayside Measurement Location Adjacent to Embankment Sections

Measurements were made until five to seven good pass-by noise levels were obtained with the microphones placed at both 15 ft. and 25 ft. from the right-of-way. For each measurement, train speed, the number of cars, and the car type of each train were noted. Following these measurements, the channel 1 microphone was moved out to 50 ft. from the centerline of the measurement track and the channel 2 microphone was moved out to 75 ft. from the measurement track. Measurements were again made for five to seven train pass-bys for the new measurement locations.

Finally, if space permitted, a microphone was moved 100 ft. from the track and noise measurements were again taken. However, for some locations it was not possible to obtain the 100 ft. noise recording because of the proximity of buildings or obstructions.

For all microphone placement locations at least one 10 minute continuous sampling was obtained to measure ambient noise levels at the site.

In the laboratory, the magnetic tape records of train pass-by noise levels and ambient site noise levels were processed using procedures identical to those used for the in-station noise records as described in Chapter 5. Values of peak noise levels in dBA and the time duration for noise levels 5 dBA down from the peak noise level were evaluated, tabulated, summarized and digitized for computer processing. These data are presented in Appendix G.

6.4 WAYSIDE NOISE LEVELS

A typical time history of wayside community noise levels for a 2-car, 2000 series vehicle pass-by on an elevated steel rapid transit structure is shown in Fig. 6.8. The form of this

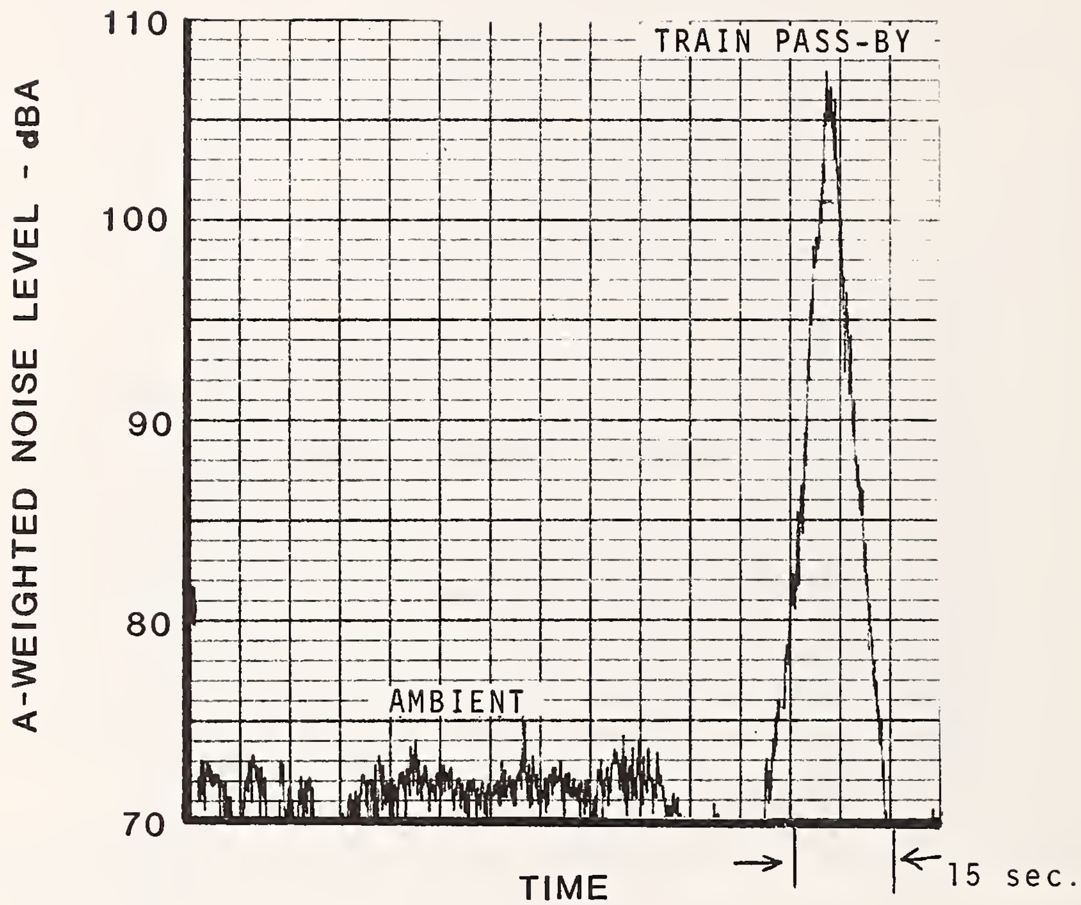


Fig. 6.8 Typical Form of Time History for Wayside Community Noise Levels for Elevated Steel Structures (Douglas Structure). Microphone Distance - 15 ft from Track at Ground Level

time history is representative of the majority of the train pass-by information obtained in this program. For example, an ambient noise level may be noted which is fairly uniform with time. During the train pass-by, the noise level increases sharply to a peak value, and then decreases rapidly back to ambient levels.

In contrast to this form of time history, Fig. 6.9 shows a typical time history obtained at the edge of a highway containing a median strip rapid transit line (Congress Service). It may be seen that the ambient noise level is significantly higher than levels adjacent to the elevated structure (Fig. 6.8) and that truck pass-bys, especially in the lane nearest to the recording microphone, reached levels of approximately 80 dBA. It may further be seen in the figure that train pass-by generated noise levels are no higher than truck-generated noise levels. Moreover, in many cases it was difficult to distinguish that a train had passed by without a visual observation. Thus, it was concluded that rapid transit operations are not a significant source of community noise along highway median strips.

Two-car trains are the most commonly used configuration on most of the CTA rapid transit lines, and therefore the majority of wayside noise measurements were for this train length. For these 2-car trains, an average of four to five train pass-bys showed highly reproducible peak noise values varying on the order of 1 dBA were always obtained for the same train type and the same pass-by speed.

An effort was made to investigate the effect of car type on measured wayside noise levels. However, for trains traveling at the same speed, there was no significant difference in wayside

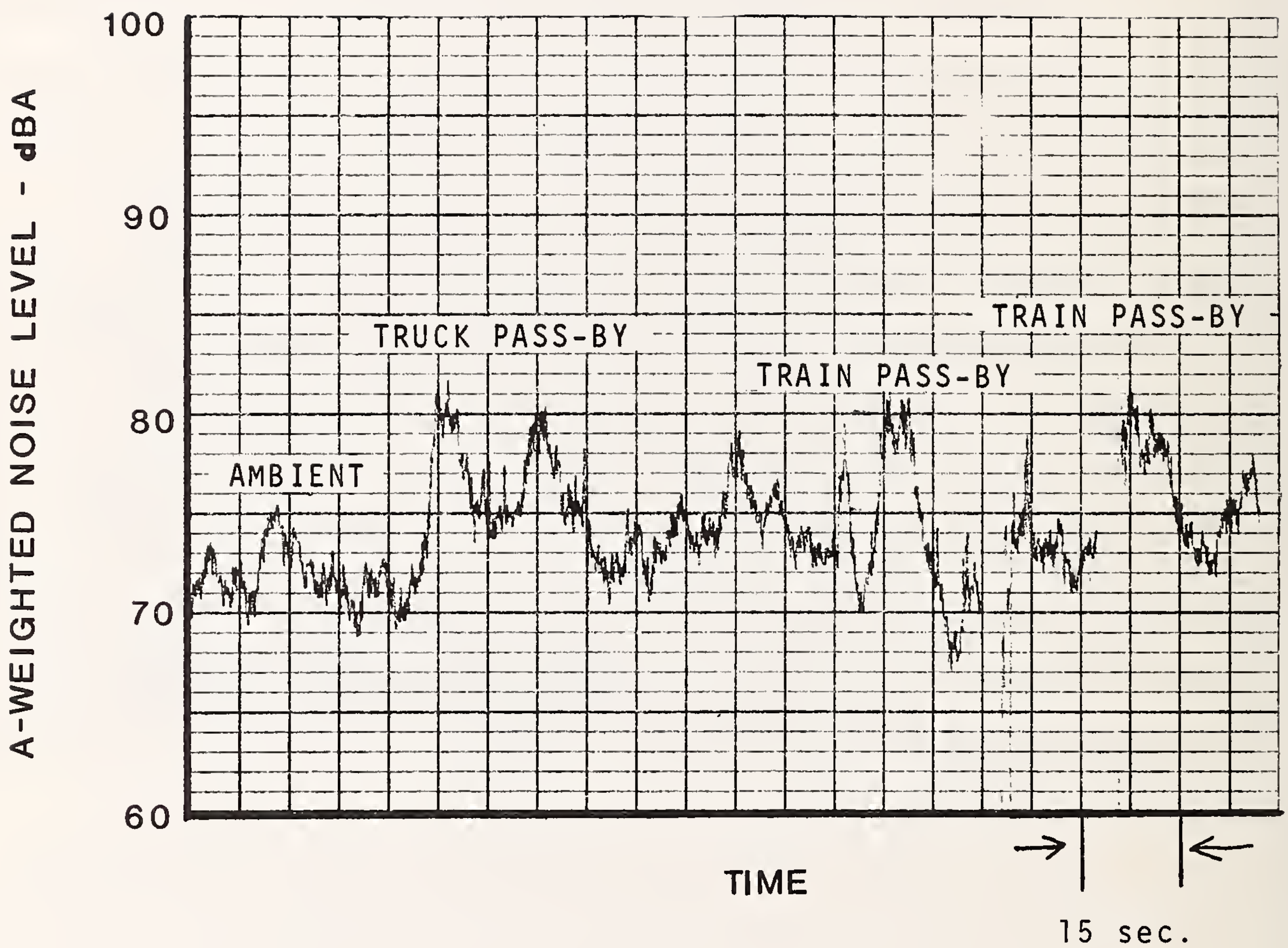


Fig. 6.9 Typical Time History of Wayside Community Noise Levels for Median Strip Operation (Congress Service)

noise values for the various classes of cars (2000, 2200, and 6000 series) used on the CTA system. In addition, an evaluation of the noise levels generated by trains of different numbers of cars with trains traveling at the same speed showed that peak dBA levels did not change as the number of cars increased, at least at a distance of 100 ft or less from the track. There was a change, however, in the time duration for noise levels 5 dBA down from peak noise levels. The longer the train, the longer the time duration of the signal 5 dBA down from the peak. These values are given in Appendix G.

On the other hand, it was found that train speed was a significant factor in determining wayside noise levels. The higher the speed, the higher the noise generated. This effect is shown on Fig. 6.10, where the change in peak noise levels measured in dBA is plotted as a function of train speed for the same car type and number of cars at the same measurement location. It may be seen that the slope of each curve is approximately equivalent, indicating that there is a reduction of approximately 6 dBA for every 10 mph reduction in speed for train speeds below approximately 50 mph. However, for trains traveling at 50 mph and above, limited measurements showed that there was no effect of train speed on measured peak noise values.

The effect of structure type and distance from the track on measured wayside noise levels is shown in Fig. 6.11. The recorded noise levels made for different train speeds has been normalized to approximately 33 mph using the relationships shown on Fig. 6.10. It may be seen that for a constant train speed, elevated steel structures on steel columns are the noisiest

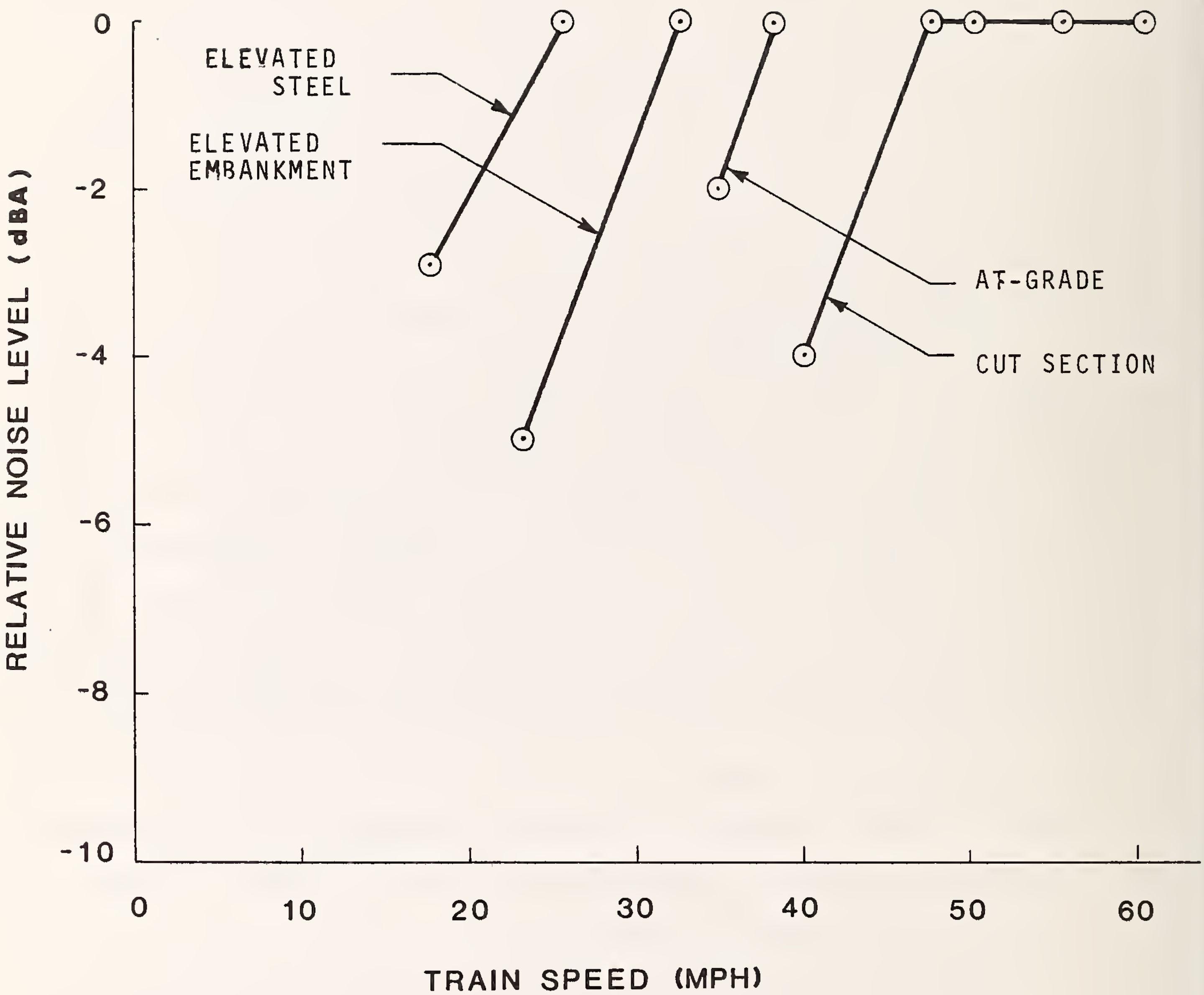


Fig. 6.10 Effect of Train Speed on Measured Wayside Noise Levels at the Same Measurement Location

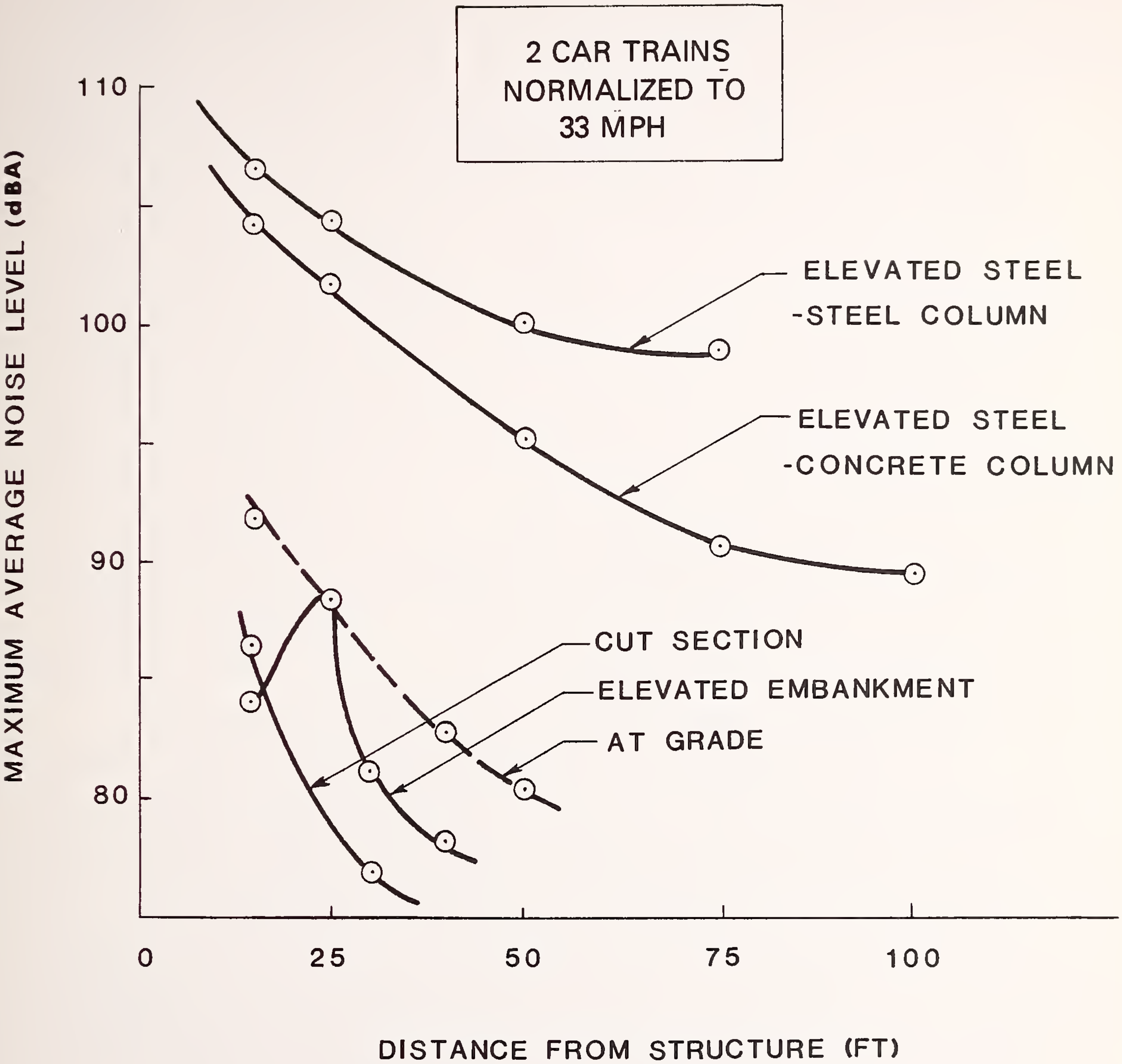


Fig. 6.11 Effect of Structure Type and Distance from the Track on Wayside Noise Levels. (Each data point is averaged for 5 to 6 train pass-bys.)

structure type, and that a steel structure on concrete columns may be as much as 5 dBA quieter at distances of 50 ft. from the structure. It may also be seen in the figure that at-grade structures may be as much as 20 dBA quieter than steel structures and that elevated embankments and cut sections are even quieter.

Fig. 6.11 also shows the effect of distance from the track on wayside noise levels indicating, as found by most researchers, that noise levels decrease significantly at increasing distances from the right-of-way. For example, for steel elevated structures on steel columns, there is a decrease of approximately 7 dBA from 15 ft. to 50 ft. from the track. For the elevated steel structure on concrete columns, this decrease is a little greater, representing about 9 dBA. The decrease in noise levels is even more significant for at-grade structures, where a decrease was noted of approximately 12 dBA from 15 ft. to 50 ft. from the track.

The curve representing the maximum noise levels as a function of distance from the track for the elevated embankment structure type has a little different shape than the other curves. At 15 ft. from the track, noise levels are relatively low. But levels increase at about 25 ft. from the right-of-way and then decrease again in the same way as the at-grade noise levels decrease with distance. This effect is caused by blocking of the noise, because there is no direct transmission path from the structure to the microphone at close distances. This "shadow zone" effect decrease at increasing distances out from the structure as soon as the direct noise transmission path becomes operative.

A special consideration of wayside noise levels must be made for median strip structure types, since only one location immediately

adjacent to the highway on top of the concrete retaining wall was used for each measurement. In general, the ambient noise levels for general traffic conditions adjacent to median strip structure at the measurement location shown in Fig. 6.4 was 75 dBA, with truck pass-bys in near traffic lanes resulting in measured noise peaks on the order of 82 dBA. Train pass-bys were found to generate peak dBA noise levels on the order of 80 dBA and the simultaneous pass-by of a heavy truck and a train resulted in the truck noise completely masking the train noise. For this reason, it was concluded that median strip rapid transit operation of the type in Chicago does not significantly influence noise levels in the wayside community above those generated by traffic on urban expressways.

6.5 SUMMARY OF WAYSIDE NOISE LEVELS

As discussed previously, each of the wayside locations where noise measurements were made is representative of specific sections of track on the CTA rail rapid transit system. Each of these measurement locations is shown, along with the number of similar locations on the system and the miles of equivalent track, in Table 6.2. The length of similar sections of track, which in this case add up to 49.5 miles, represent the single direction of travel along one side of the right-of-way and would be doubled to evaluate noise levels on both sides of the rapid transit line. Table 6.2 represents only areas along the right-of-way which have wayside communities that could be impacted by rail rapid transit noise. Thus the total track miles do not include the length of track within stations

TABLE 6.2

SUMMARY OF RIGHT-OF-WAY LOCATIONS
HAVING EQUIVALENT NOISE CLIMATES

Representative Location	Number of Similar Locations	Miles of Similar Locations[1]	% Total Track[2]
CON 10	5	1.52	2.4
12	2	.49	0.8
13	6	.92	1.4
33	91	13.91	21.9
DAN 71	2	.30	0.5
72	5	.49	0.8
DPK 28	114	28.07	44.3
29	22	2.29	3.6
HOW 21	10	4.13	6.5
22	6	1.32	2.1
27	2	.55	0.9
LAK 10	10	2.29	3.6
11	2	.26	0.4
MIL 21	8	.79	1.2
RAV 2	1	.06	0.1
5	14	3.06	4.8
7	6	.89	1.4
11	6	.72	1.1
39	9	1.31	2.1
SKO 6	2	.05	0.1
Total	323	63.42	100%

[1]Distance along centerline of right-of-way.
[2]Does not include length of right-of-way in stations or above subways.

or the length of subway track, since there is no affected wayside along these sections of the system. Thus there is approximately 127 miles of wayside community (on both sides of the rapid transit track) in contact with rapid transit noise.

Since the distance to wayside structures changes along each section of equivalent right-of-way in the rapid transit system, a meaningful way to present wayside noise levels should be based not only on the physical characteristics of the sections but also on the distance to the nearest impacted structure. This has been done in Table 6.3, which shows each characteristic wayside measurement location and the distance to the nearest impacted structure along equivalent right-of-way sections, divided into three categories of 15 ft from the track, 50 ft from the track, and 100 ft from the track. The table then shows the average noise level for the different sections for increasing distances to the wayside. Since this table normalizes the physical characteristics along each section of track, the noise level ranges are equivalent for track geometry and operating speed typical of that section.

Equivalent wayside noise levels at the nearest impacted structure are tabulated in Table 6.4 and represented graphically in Fig. 6.12.

It may be seen that there are 20 miles of right-of-way with structures 15 ft. from the nearest track where the noise levels are predominantly 105 to 110 dBA. There are also 5 miles of right-

TABLE 6.3

EQUIVALENT NOISE LEVELS AT THE LOCATION OF THE NEAREST IMPACTED STRUCTURE ALONG THE TRANSIT RIGHT-OF-WAY

Representative Physical Location	Wayside Mileage[1] 15 ft. (0-25 ft. range)	dBA Range	Wayside Mileage[1] 50 ft. (25-75 ft.)	dBA Range	Wayside Mileage[1] 100 ft. (> than 75 ft.)	dBA Range
DPK 28	20.42	105-110	5.59	100-105	2.06	100-105
RAV 39	1.21	100-105	.09	90-95	-	-
DPK 29	1.78	90-95	.23	80-85	.28	75-80
LAK 10	.81	90-95	1.48	90-95	-	-
LAK 11	.07	80-85	.18	75-80	-	-
RAV 11	.64	85-89	.08	75-80	-	-
HOW 27	.56	80-85	-	-	-	-
CON 33	- (Median Strip)		-	-	13.91	80-85
CON 10	-	-	1.52	80-85	-	-
CON 12	-	-	.49	85-90	-	-
RAV 5	.91	90-95	.72	80-85	1.43	75-80
RAV 7	.44	85-90	.36	80-85	.09	80-85
RAV 2	.06	100-105	-	-	-	-
MIL 21	.07	85-90	.19	90-95	.53	85-90
CON 13	.08	90-95	.03	80-85	.80	75-80
HOW 21	.17	85-90	3.60	75-80	.36	70-75
HOW 22	.25	80-85	.28	80-85	.79	75-80
MIL 22	-	-	.07	90-95	-	-
DAN 72	-	-	-	-	.42	75-80
DAN 71	-	-	.02	85-90	.18	85-90
Total	27.47		14.93		20.85	

[1] Distance along centerline of right-of-way included distance along median strip but not distance in stations or above subways.

TABLE 6.4

SUMMARY OF WAYSIDE NOISE LEVELS ALONG THE TRANSIT RIGHT-OF-WAY AT THE NEAREST IMPACTED STRUCTURE

	No. of One Way Miles for Nearest Impacted Structure		
Noise Range	15 ft. from Row	50 ft. from Row	100 ft. from Row
70-75	-	-	.36
75-80	-	3.86	3.72
80-85	.88	3.14	14.0
85-90	1.32	.51	.71
90-95	3.58	1.83	-
95-100	-	-	-
100-105	1.27	5.59	2.06
105-110	20.42	-	-
110-115	-	-	-

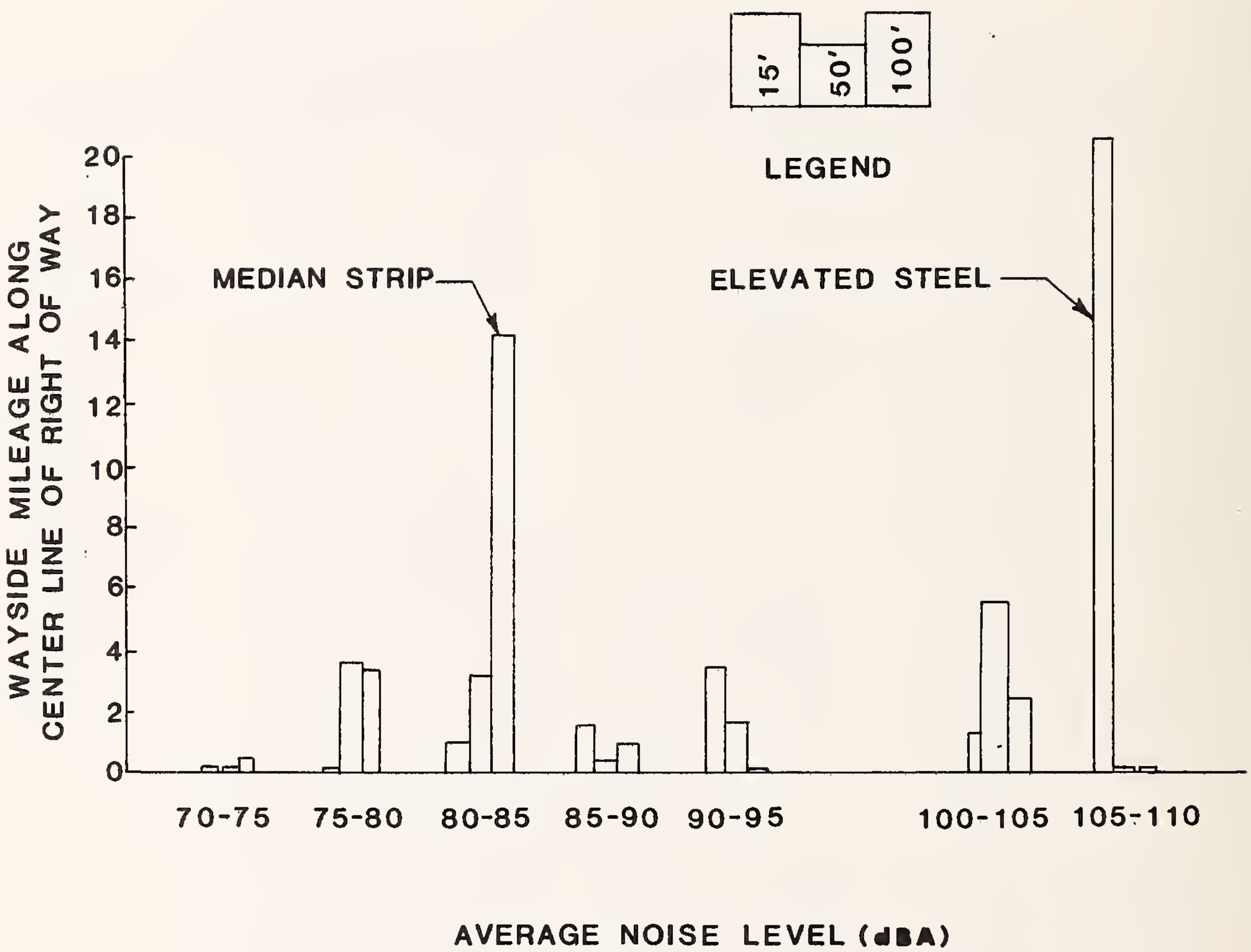


Figure 6.12 Histogram Showing Noise Levels Along the Transit Right-of-Way

of-way with noise levels between 100 and 105 dBA at the nearest structure. At 100 ft. from the right-of-way, the majority of track is in the 80-85 dBA range. The large amount of track mileage with noise levels in the 105 to 110 dBA range reflects areas adjacent to elevated steel structures.

7. BIBLIOGRAPHY

Franken, P.A., R.D. Strunk, and W.J. Galloway, "Chicago Urban Noise Study, Phase III -- Noise Control Technology," Bolt Beranek and Newman, Inc., Cambridge, Mass. Nov. 1970.

Kurzweil, L.G., R. Lotz, and E.G. Apgar, "Noise Assessment and Abatement in Rapid Transit Systems," Report No. UMTA-MA-06-0025-74-8, Sept. 1974.

Newson, D. and R. Lotz, "A Computer Program for Minimizing Noise Control Costs on Rail Systems," Internal Report, Transportation Systems Center, Cambridge, Mass. Dec. 1974.

Peterson, A.P.G., and E.E. Gross, Noise Measurement, General Radio, 1972.

Priemer, R., and M.L. Silver, "Data Management Methods for Urban Mass Transportation Systems," Report No. UMTA-IL-11-007-3, Sept. 1975.

Schultz, T.J., "Development of an Acoustic Rating Scale for Assessing Annoyance Caused by Wheel/Rail Noise in Urban Mass Transit," Report No. UMTA-MA-06-0025-74-2, Feb. 1974.

APPENDIX A

DESCRIPTION OF COMPUTER DATA MANAGEMENT SYSTEM

A.1 Introduction

The volume of data needed for this noise study forms an extensive and complex data base. For the useful analysis of this data, it was necessary to develop a computer-based data management system for:

(a) convenient data entry into the data files,

(b) absence of bounds on the amount of data collected,

(c) ease of data manipulation,

(d) rapid access to specific data in the files, and

(e) obtaining data representations in any format.

The Data Management System (DMS) was designed to be widely used throughout the transit industry and therefore meets the following requirements:

(a) The code is transferable from one computer system to another.

(b) Use of the system is easy and convenient and does not require any prior computer programming experience.

(c) The DMS code is written in widely used computer language.

(d) Only a minimum of data oriented instruction is required to use the system.

(e) To allow for a number of users the system is accessible from remote terminals connected to a central computing facility.

The Data Management System code was written in the FORTRAN language. Much of the data to be manipulated is in character rather than numerical form, indicating that a language such as SNOBOL or LISP might be more appropriate and efficient. However, a significant amount of numerical analysis was expected, such as noise data spectral analyses and noise abatement cost optimizations which are available in the FORTRAN language. Therefore, the use of FORTRAN makes it easy to link the system with existing analysis methodologies. Moreover, the use of FORTRAN allows for modifications to the code by other users to meet specific data management needs for other mass transit problems.

For further reference, a basic computer system configuration is shown in Figure A.1. The noise and physical characteristics data files and the system codes reside in disk storage and, as a back-up, in tape storage. The user can request the Data Management System from the computer from a remote terminal. The user then enters easily composed requests to the DMS by typing

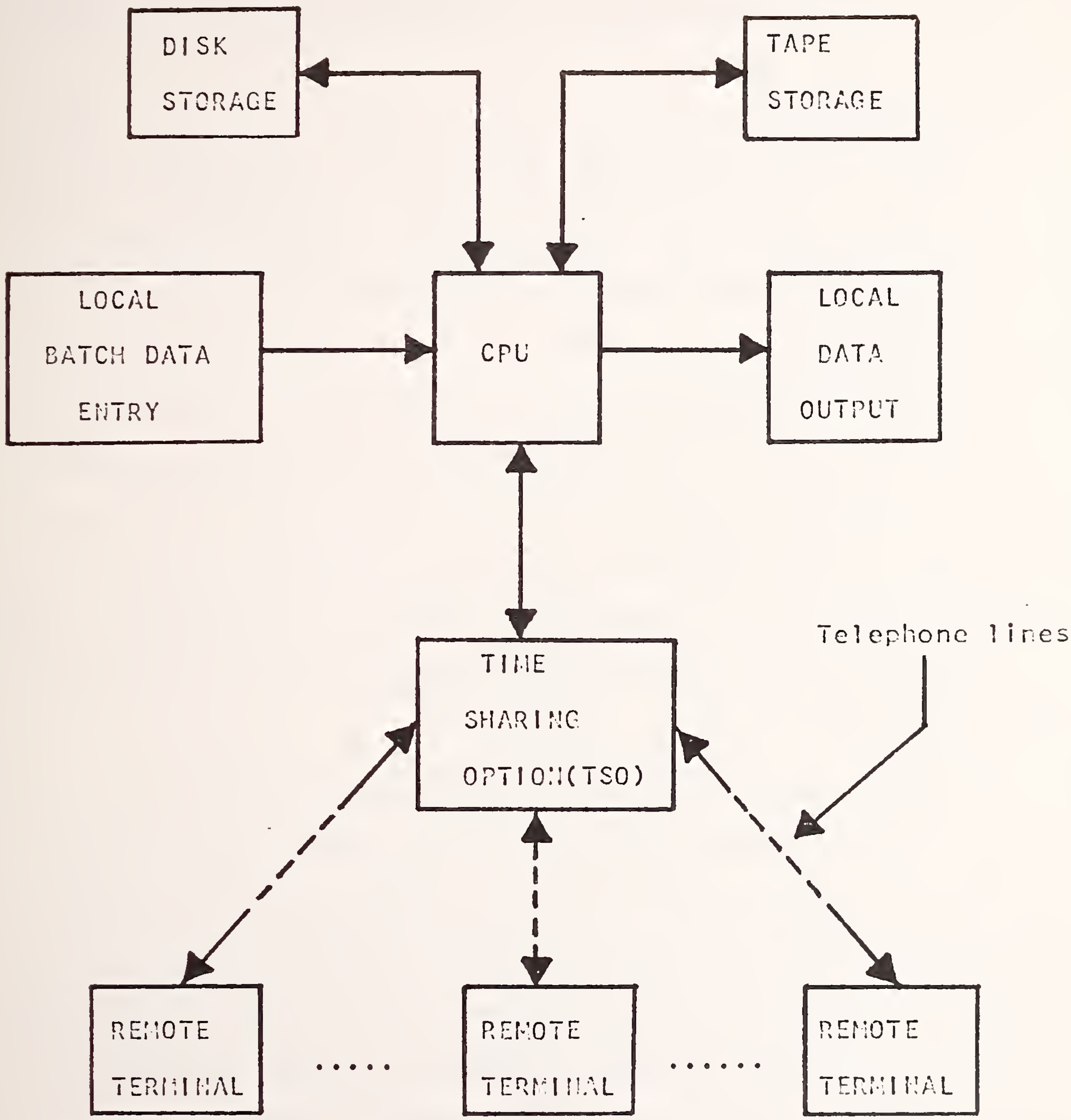


Fig. A.1 - Data Management System Computer Configuration

instructions at the remote terminal, where Data Management System responses will also appear.

A.2 Data Management System

The style of the Data Management System is interactive and conversational. Input to the DMS is itself a small language which is oriented to the needs of manipulating noise and physical attributes data for the development of noise abatement methodologies. The entire system usage instruction manual appears in Appendix A.3. Since the system was written to include a highly interactive feature, detailed instructions are given to the user by the system only when they are needed or requested by the user. Basically, the program was developed so that its use may be learned on-line rather than by first becoming familiar with an extensive instruction manual.

In managing a data file, only a few basic operations are necessary. These are the ability (a) to add data, (b) to delete data, (c) to retrieve specific data for display, and (d) to use functions for problem/data oriented data manipulation and searching. In addition, features that describe how to correctly use the system are necessary. Data management commands are shown in Table B-1, which also describes their use. More detailed information on the Data Management System, including details of its programming features, are described elsewhere.*

* Priemer and Silver, "Data Management Methods."

TABLE A.1

THE DATA MANAGEMENT SYSTEM COMMAND LANGUAGE

SHOW: Displays previously stored data

ADD: Enters data from a remote terminal into the files

DELETE: Removes data from a remote terminal from the files

FIND: Scans the data to find rapid transit system locations or sections with the same physical characteristics

HELP: Displays information on how to use the system

LINK: Generates a linked list data structure

STOP: Terminates use of the program.

The Data Management System, combined with the physical attribute files and noise data files developed in this research, provides an important evaluation and planning tool for noise, maintenance and other transit-related problems. A few of the many uses of the system are shown by the following examples.

To display physical attribute information for a CTA survey map location, the following instruction would be entered at the computer terminal:

SHOW CTA # DP25300

The designation DP25300 is similar to the CTA convention for locating a specific point in the transit system, where DP refers to the name of a particular transit line and 25300 is the distance in feet from the DP line reference point. If information for this location is not present in the file, then the information for the location closest to the specified location will be displayed. Alternatively the following instruction entered at the terminal:

SHOW MAP # DPK21

would result in the information shown in Table 3.3 being displayed at the terminal. This is a complete description of the physical characteristics for that section of track.

In some cases such as maintenance scheduling, it may be useful to know the location and length of track for all transit sections adjacent to quiet zones (Code 1(6)) on elevated steel structures (Code 3(1)) where the track is bolted rail with wood ties (Code 5(2)). The following computer instruction

FIND(SHOW) 1(6) and 3(1) and 5(2)

would give the printout shown in Table A.2, which indicates where

TABLE A.2

EXAMPLE OF USING THE FIND(SHOW) COMMAND

```
find(show) 1(6) and 3(1) and 5(2)

PHYSICAL ATTRIBUTE(S)
 WAYSIDE COMMUNITY TYPE: QUIET ZONE
 STRUCTURE TYPE: ELEVATED STEEL
 TRACK TYPE: BOLTED RAIL WITH WOOD TIE
EXIST(S) IN
DPK33  DP  11800 TO DP  13500 (ROOSEVELT - POLK STS)
DPK34  DP  11100 TO DP  11800 (POLK STATION        )
DPK35  DP  10600 TO DP  11100 (FLOURNOY - HARRISON )
JAC35  SML 13700 TO SML 16200 (34TH. - 30TH. STRTS.)
   4 RECORD(S) FOUND WITH TOTAL DISTANCE INVOLVED = 1.0225 MILES

PROCEED
```

all of these track locations are on the system and the total distance of track involved. Such information is basic to cost estimates for maintenance planning and similar studies.

In other cases a printout of the noise levels recorded for a section of track may be needed. Typing in the following terminal instruction

SHOW(NOISE) MAP #SK03

gives the computer printout shown in Table A.3, which is a full picture of the physical characteristics and associated noise levels generated on the section of track in question.

The above examples give only a suggestion of the many uses for the Data Management System developed for this research. The reader is directed to the usage instruction manual in the following pages as well as the report by Priemer and Silver (1975) for further details and examples.

TABLE A.3

EXAMPLE OF USING THE SHOW(NOISE) COMMAND

```
show(noise) map #sko3

*****************************************************************************
FOR CTA LOCATION SK  21700 TO SK  24400
THE MAP LOCATION IS SK03  (MILES CN RD - SEARLE).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: MANUFACTURING
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: AT-GRADE
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
SK  24400-SK  21700 AT 11: 1 ON  DEC 10, 1974
 1 CAR INBOUND TRAIN NUMBER 6228, SPEED=45 MPH,  COOL AND OVERCAST
CAR PATRON DENSITY: VERY LIGHT
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   68 DBA
DBA CURVE ON TAPE    3 IS FLAT(RECTANGULAR),  INTERSECTION V 82
MAX. PEAK =  81 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  81 DBA WITH DURATION(-5 DBA) =  12.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
PASSENGER NOISE
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
IN - CAR NOISE MEASUREMENT FOR
SK  24400-SK  21700 AT 12:21 ON  DEC 10, 1974
 1 CAR INBOUND TRAIN NUMBER 6228, SPEED=32 MPH,  COOL AND OVERCAST
CAR PATRON DENSITY: VERY LIGHT
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   65 DBA
DBA CURVE ON TAPE    3 IS FLAT(RECTANGULAR),  THROUGH TOWN
MAX. PEAK =  82 DBA WITH  3 PEAKS WITHIN -5 DBA
PLATEAU =  80 DBA WITH DURATION(-5 DBA) =  40.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
PASSENGER NOISE
NOISE SOURCES VERY NOTICEABLE
MISC. EXTERIOR NOISE
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
*****************************************************************************

PROCEED
```

A.3 Data Management System Usage Instruction Manual

Lower case letters are input to the DMS program, and upper case letters are the response of the DMS.

```
exec dms
ENTERED CTA DATA FILE PROGRAM
ARE INSTRUCTIONS REQUIRED, YES OR NO?
yes
    THIS IS A PROGRAM FOR MANIPULATING THE CTA NOISE AND PHYSICAL AT-
 TRIBUTES DATA FILES. THE USAGE STYLE OF THIS PROGRAM IS CONVERSATIONAL.
 ALL INPUT IS IN FREE FORMAT. HOWEVER, EACH LINE OF YOUR INPUT SHOULD
 NOT EXCEED 72 CHARACTERS(INCLUDING BLANKS), AND NO BLANKS ARE ALLOWED
 WITHIN INPUT WORDS. INPUT TO THE PROGRAM IS TYPED EITHER BECAUSE IT IS
 AN INSTRUCTION COMMANDING THE PROGRAM TO DO SOMETHING(TYPED IN AFTER
 THE WORD 'PROCEED' APPEARS) OR BECAUSE IT REPRESENTS YOUR RESPONSE TO A
 QUERY BY THE PROGRAM. THE PROGRAM CANNOT READ IN THE TYPED INPUT UNTIL
 AFTER THE RETURN KEY HAS BEEN DEPRESSED. IF YOU MAKE ANY ERRORS, THEN
 YOU WILL BE APPROPRIATELY INFORMED AND GIVEN THE OPPORTUNITY TO REENTER
 YOUR INPUT. WHILE OUTPUT IS BEING TYPED, AN INTERUPTION WILL CAUSE AN
 IMMEDIATE TERMINATION OF THE USE OF THIS PROGRAM. IF YOU DISCOVER A
 TYPING MISTAKE BEFORE YOU DEPRESSED THE RETURN KEY, THEN BACKSPACE AND
 RETYPE THE LINE STARTING AT THE CORRECTED CHARACTER.
    CURRENTLY, THE OPERATIVE COMMANDS ARE: SHOW, LINK, DELETE, ADD,
 HELP, FIND, AND STOP. FOR FURTHER INSTRUCTIONS, USE THE HELP COMMAND
 WITH NO OPERAND OR WITH ONE OF THE OTHER INSTRUCTIONS AS AN OPERAND.
PROCEED
stop
TERMINATED USE OF THE DMS FOR THE CTA
```

Given here are a variety of command usage examples. Each of the following lines represents a line of user entered instructions to the DMS.

```
help instructions
help codes
help link
show cta #dp25000 #mi110250
show(noise) map #con5 #dan13 #lak21
add physical attributes
add noise
delete map #dan13
delete(noise) cta #mi110250
delete(noise) all
find 10(1) 1(1)and2(3)and6(1)
find(show) 3(4)and5(2)and7(3)
find(show noise) 4(1)and3(1)and5(3)
link noise
link physical attributes
help commands
stop
```

Only user-to-DMS inputs are shown above.

The following describes how data cards for batch entry into the files are composed. Since much of the data involves the use of descriptive phrases rather than numerical information, integer codes for these phrases as described in Tables 3.1 and 3.4 are used in the data cards to conserve file storage requirements.

The format for a physical attributes data set of an RRTS location or section, which consists of one data card, is (6A1,19A1,1X,10A2,2X,10(I2)) , where:

DATA		COLUMN(S)
map designation - XXXIII		1- 6
survey map range - (XXX IIIIII-JJJJJJ)		7-25
any location or route identifier		27-46
wayside community type	see Table 3.1 for codes	49-50
wayside distance		51-52
structure type		53-54
soil or foundation profile		55-56
track type		57-58
number of tracks		59-60
track condition		61-62
track geometry		63-64
station type		65-66
service type		67-68

The format for a noise measurement data set, which consists of two data cards, is

(6A1,19A1,A1,4X,3I2,2I2,A4,1X,I2,A1,I2,2I4,1X,A1,10A2)

(15A1,5A1,I4,1X,I2,3X,I4,1X,I4,A1,1X,I4,11X,A4,10A2)

where the first data card consists of:

DATA	COLUMN(S)
map designation	1- 6
survey map measurement range	7-25
noise measurement type	26
month-day-year	31-36
hour-min.	37-40
car type/identification	41-44
number of cars	46-47
train direction	48

DATA	COLUMN(S)
train speed	49-50
horizontal measuring distance from track	51-54
vertical measuring distance	55-58
car patron density	60
any comment about the measuring conditions	61-80

and the second card consists of:

DATA	COLUMN(S)
noise sources	1-15
noise paths	16-20
peak dbA level	21-24
number of peaks within 5 dbA of max. peak	26-27
plateau dbA level	31-34
duration of measurement	36-39
shape of dbA curve	40
ambient dbA noise level	42-45
recorded tape identifier	57-60
any comment about the noise data	61-80

APPENDIX B

LIST OF SYMBOLS FOR NOISE LEVEL CHARTS (APPENDIX C)

NOISE SOURCES

Flat Wheel	
Rough Wheel	
Rail Joint	
Power Pick-up	
Rough Rail	
Wheel Squeal	
Auxiliary Noise	

NOISE PATHS

Direct Field	
Structure - Borne	
Building/Wall Reverberation	

TRACK GEOMETRY

Straight Tangent	
Curved	
Tight Radius (radius≤750')	

TRACK TYPE

Welded Rail with Concrete Tie	
Welded Rail with Wood Tie	
Bolted Rail with Wood Tie	

List of Symbols (Continued)

STRUCTURE TYPE

Elevated Steel	
Elevated Embankment	
Median Strip	
Subway Tunnel	
At-Grade	
Cut Section	
Embankment	
Elevated Concrete	
In-Station	
Underpass	
Overpass	

APPENDIX C

IN-CAR NOISE LEVELS FOR ENTIRE CTA RAIL RAPID TRANSIT SYSTEM*

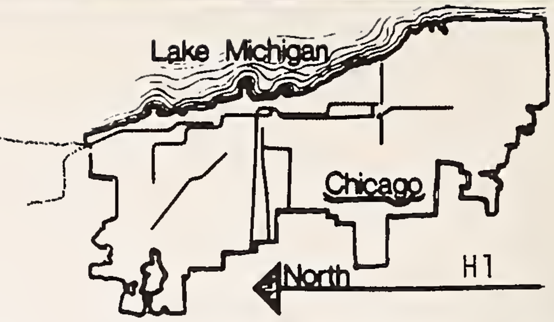
*For Englewood service from Ashland Ave. to Eggleston Ave., refer to Fig. 4-7, page 4-15.

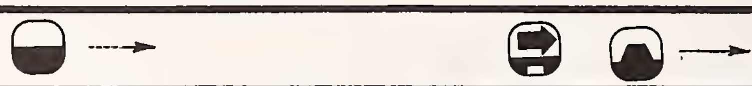
IN-CAR NOISE MEASUREMENT

ROUTE: EVANSTON SERVICE

SEGMENT: LINDEN STATION - GAFFIELD PLACE

2 CAR 6000 SERIES



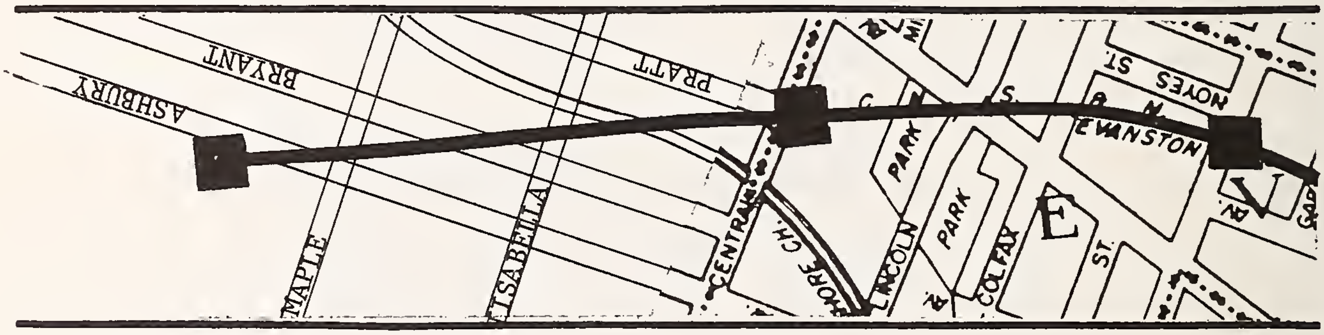
Structure 

Geometry 

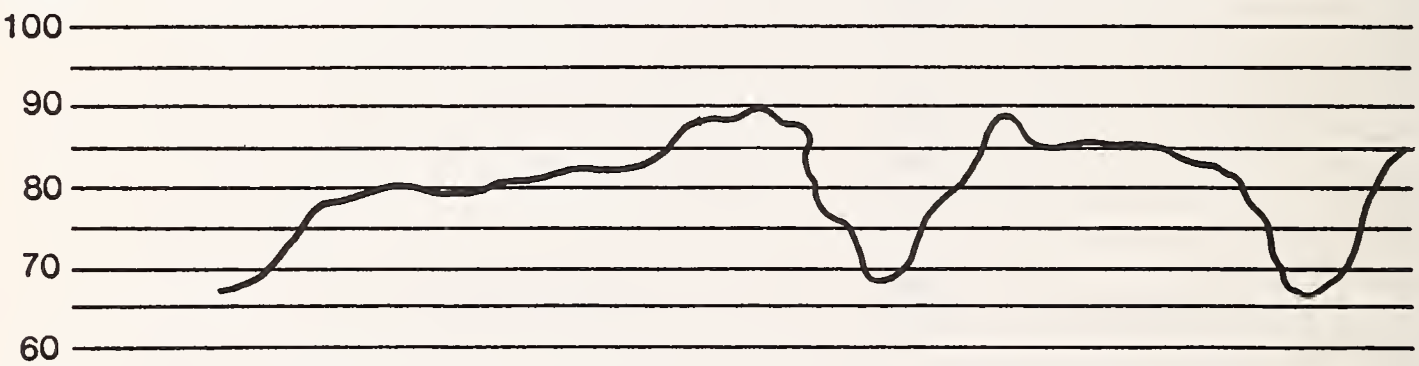
Track 

Station

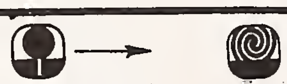
LINDEN CENTRAL NOYES

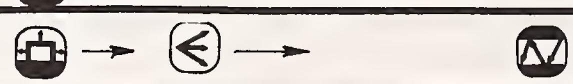


dBA



Speed (MPH)	0	35	0	35	0

Sources 

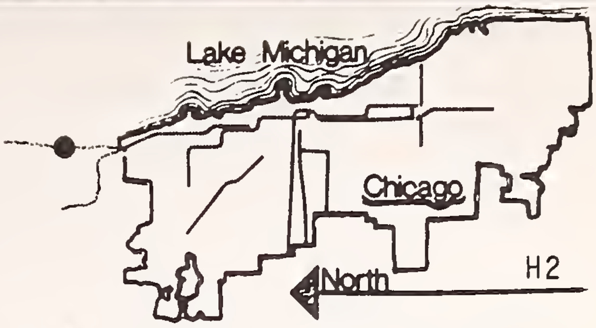
Paths 

IN-CAR NOISE MEASUREMENT

ROUTE: EVANSTON SERVICE

SEGMENT: GAFFIELD PLACE - DEMPSTER ST.

2 CAR 6000 SERIES



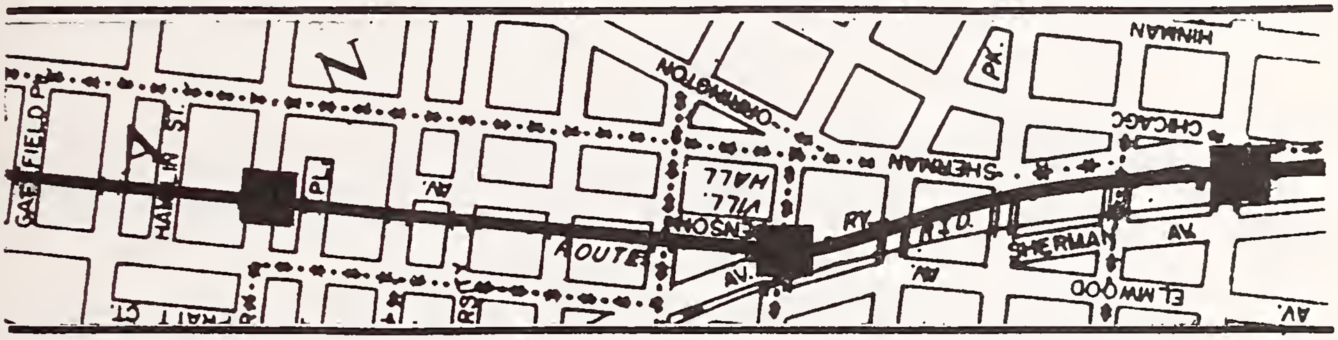
Structure

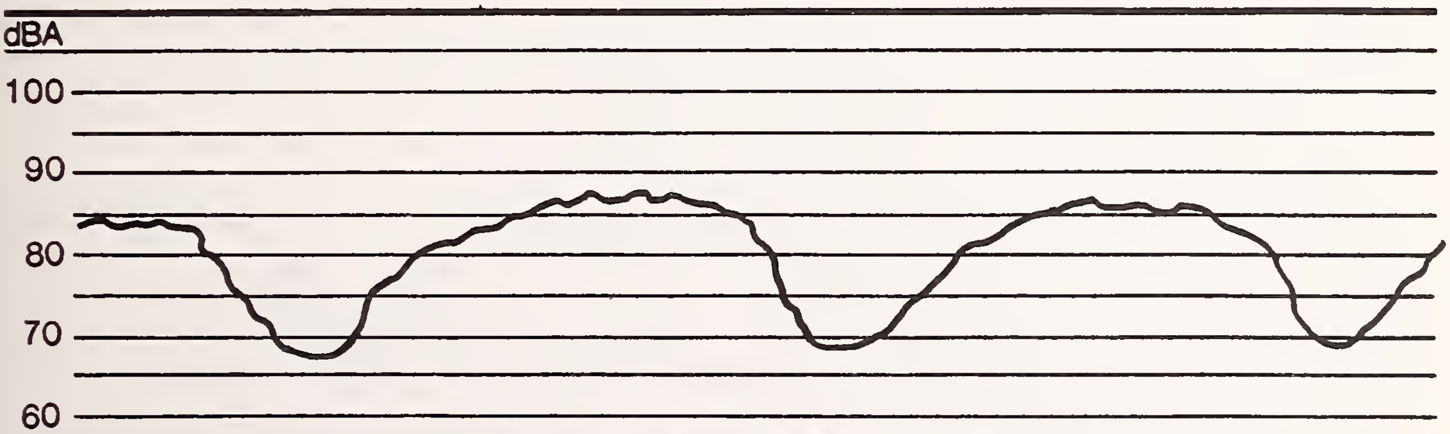
Geometry

Track

Station

FOSTER DAVIS DEMPSTER





Speed (MPH)	35	0	35	0	34	0

Sources

Paths

IN-CAR NOISE MEASUREMENT

ROUTE: EVANSTON SERVICE

SEGMENT: DEMPSTER ST. - JUNEWAY AVE.

2 CAR 6000 SERIES

Structure

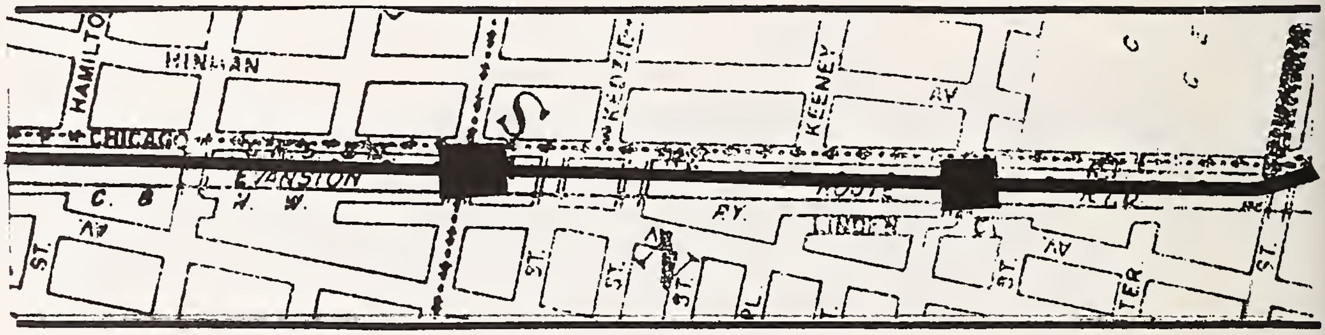
Geometry

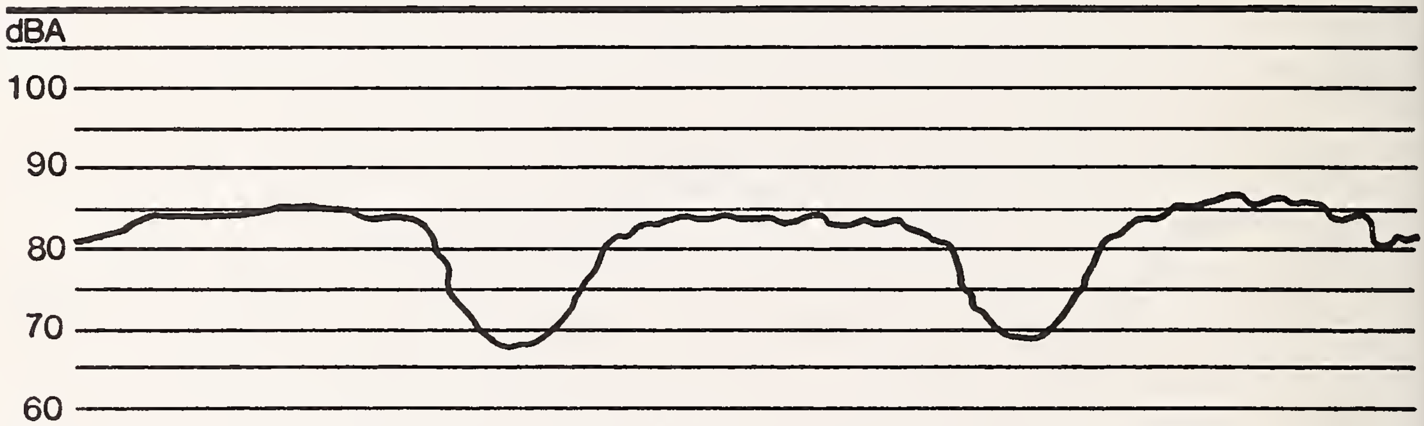
Track

Station

MAIN

SOUTH BLVD.





Speed (MPH)	35	0	32	0	33	27

Sources

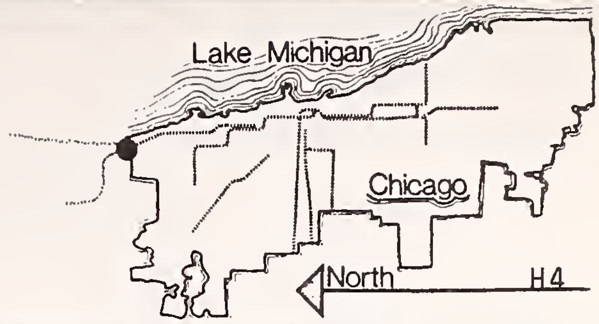
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: HOWARD SERVICE

SEGMENT: JUNEWAY AVE. - FARWELL AVE.

4 CAR   6000 SERIES



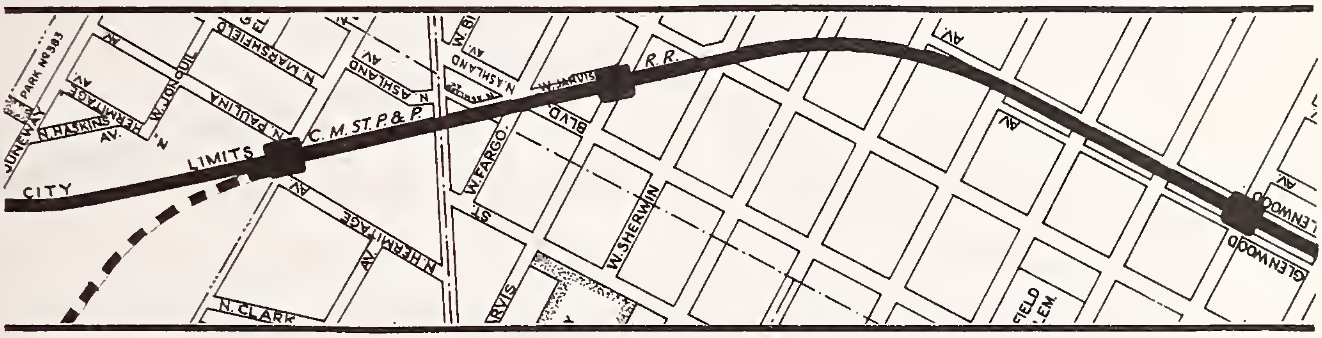
Structure

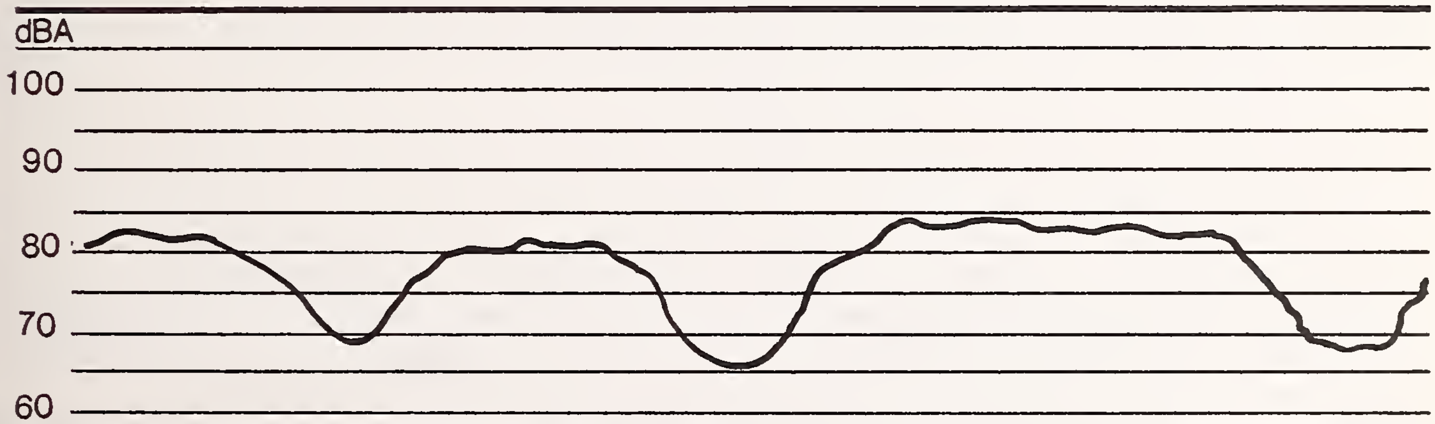
Geometry

Track

Station

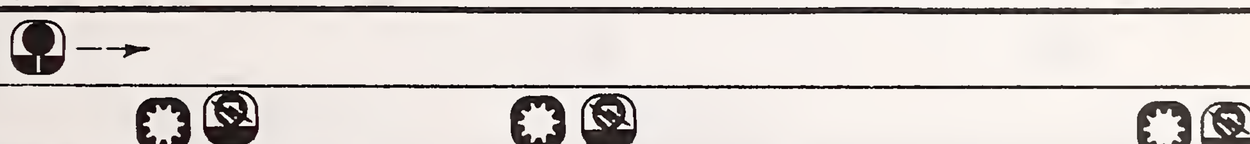
HOWARD   JARVIS (A)   MORSE (AB)



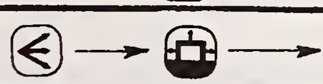


Speed (MPH) 29   0   0   34   0

Sources



Paths

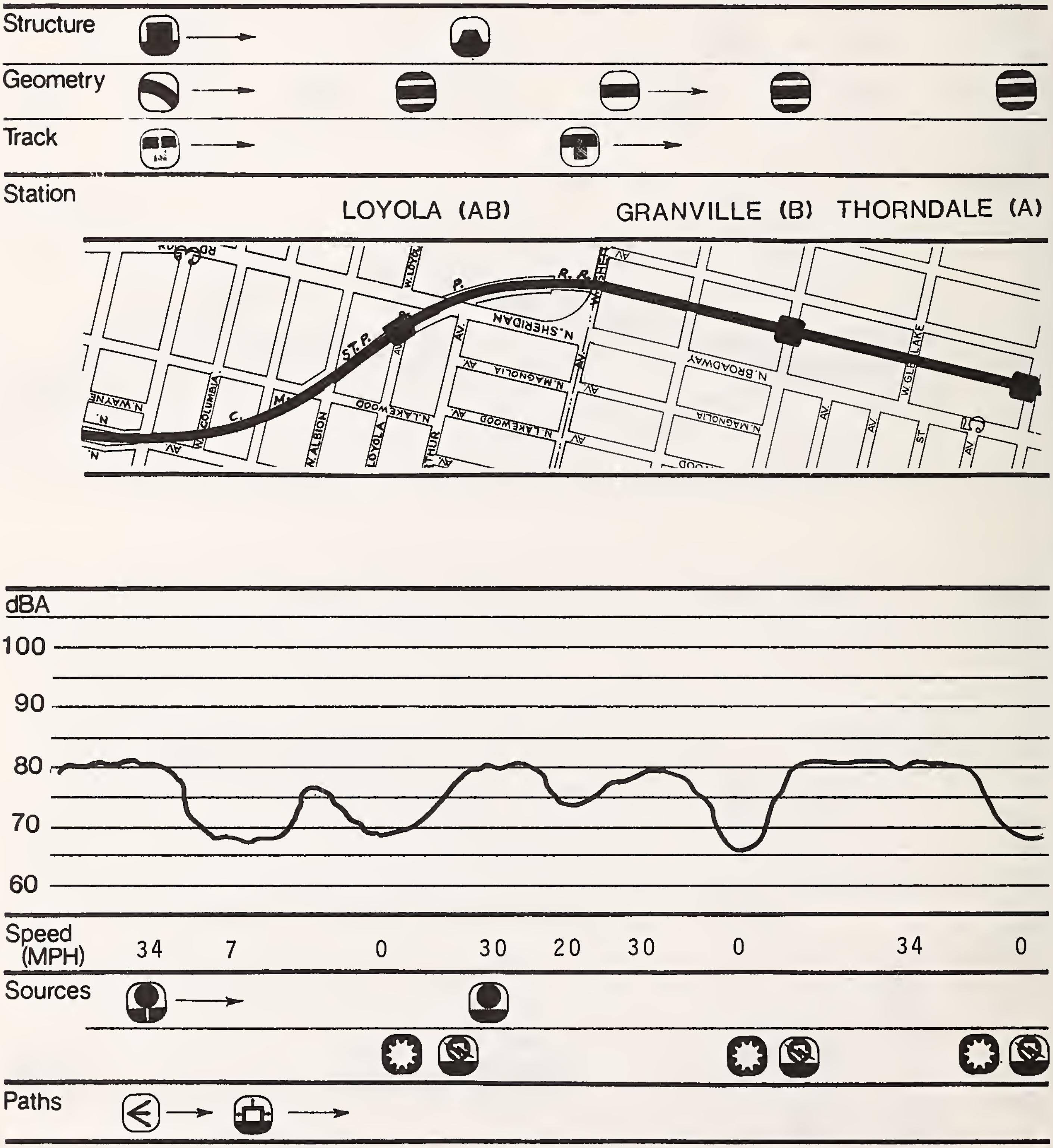


IN-CAR NOISE MEASUREMENT

ROUTE: HOWARD SERVICE

SEGMENT: FARWELL AVE. - THORNDALE AVE.

4 CAR 6000 SERIES

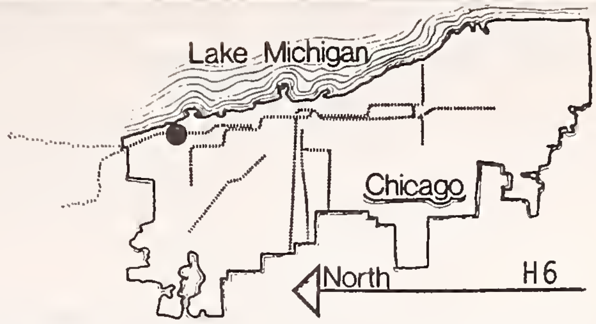


IN-CAR NOISE MEASUREMENT

ROUTE: HOWARD SERVICE

SEGMENT: THORNDALE AVE. - AINSLIE ST.

4 CAR 6000 SERIES



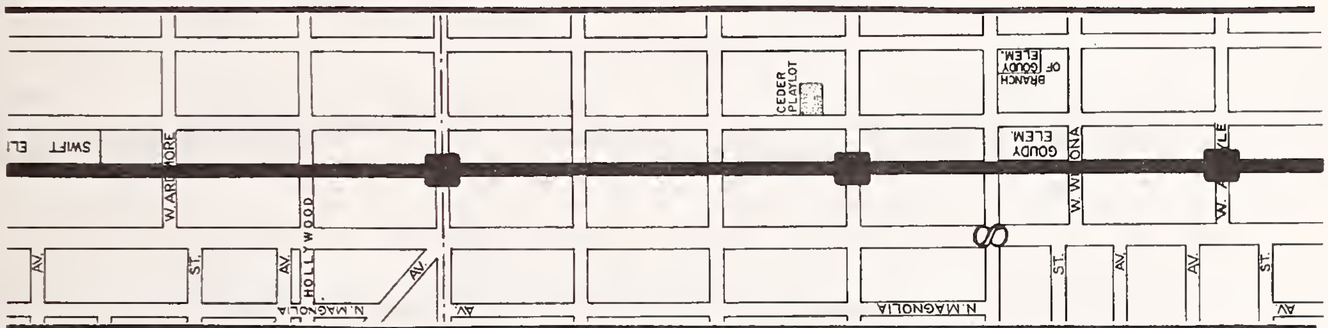
Structure

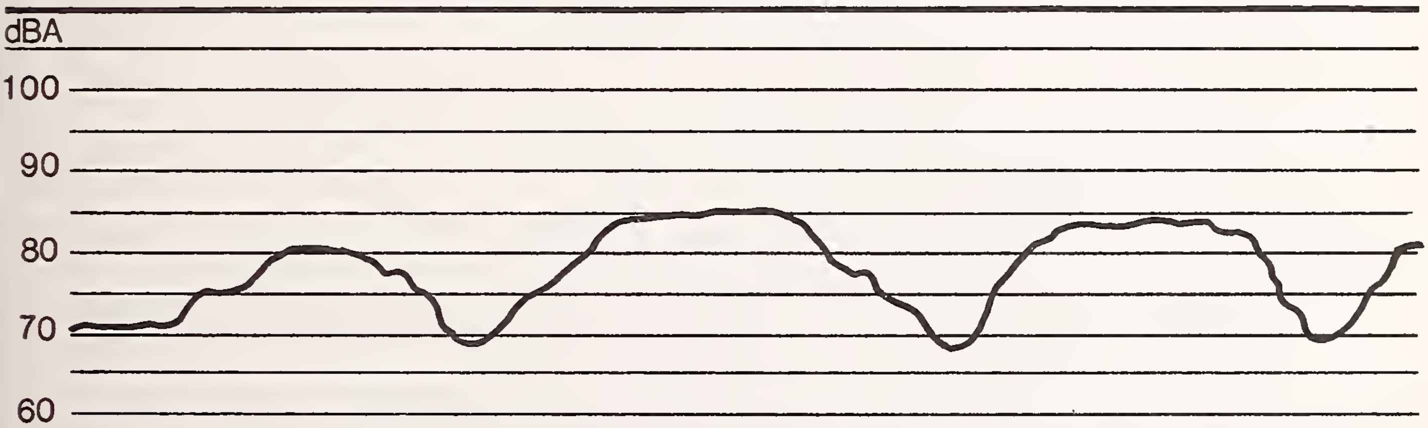
Geometry

Track

Station

BRYN MAWR (AB) BERWYN (B) ARGYLE (A)





Speed (MPH)	20	34	0	35	0	30	0

Sources

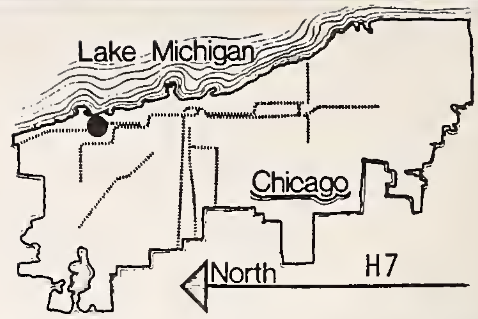
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **HOWARD SERVICE**

SEGMENT: AINSLIE ST. - IRVING PARK ROAD

4 CAR 6000 SERIES

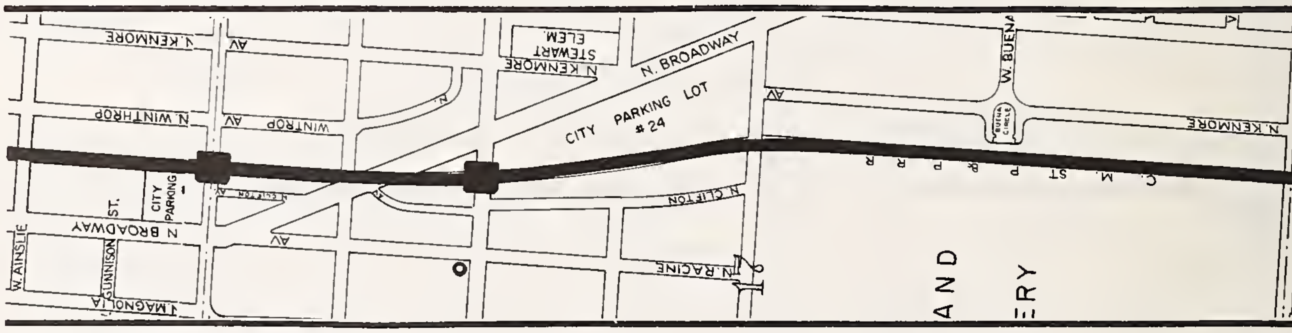


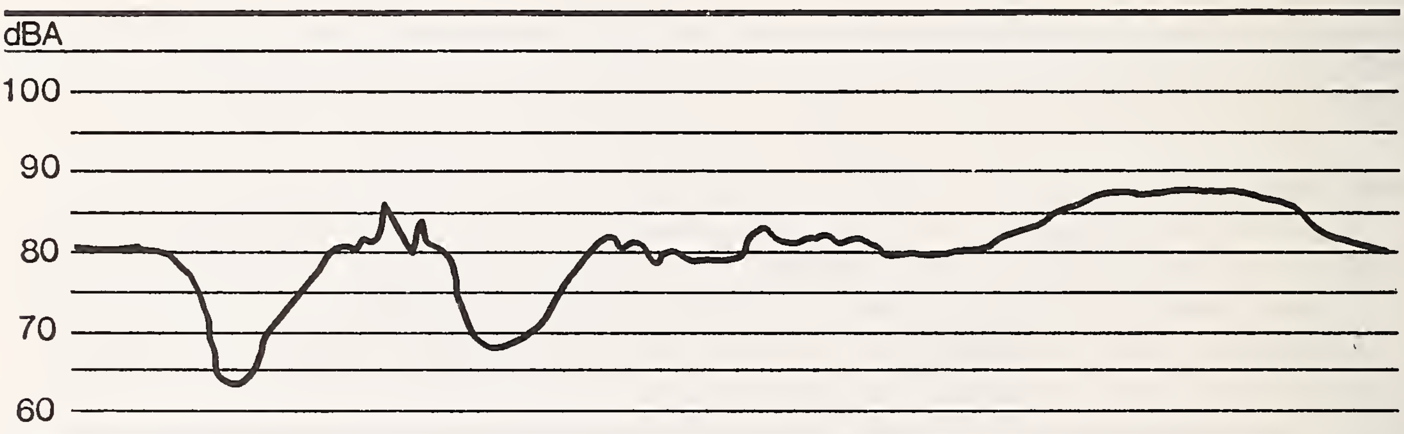
Structure

Geometry

Track

Station LAWRENCE (B) WILSON (AB)





Speed (MPH) 30 0 22 0 19 26 33

Sources

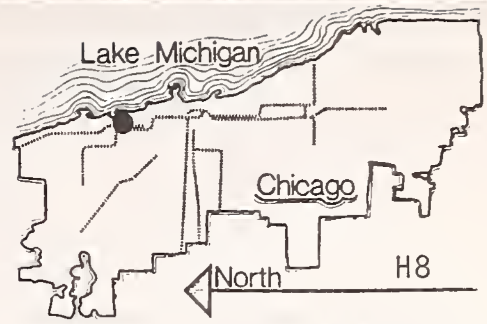
Paths

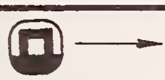
IN-CAR NOISE MEASUREMENT

ROUTE: **HOWARD SERVICE**

SEGMENT: IRVING PARK ROAD - WELLINGTON AVE.

4 CAR 6000 SERIES



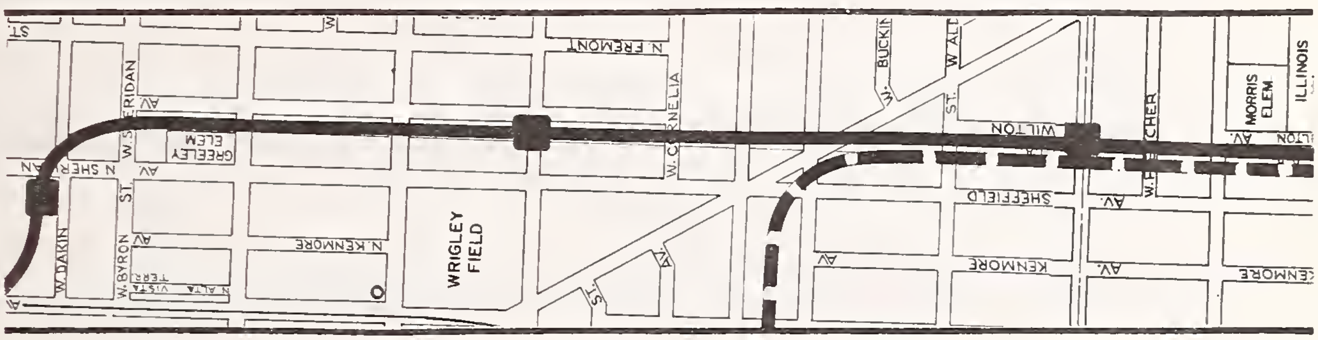
Structure 

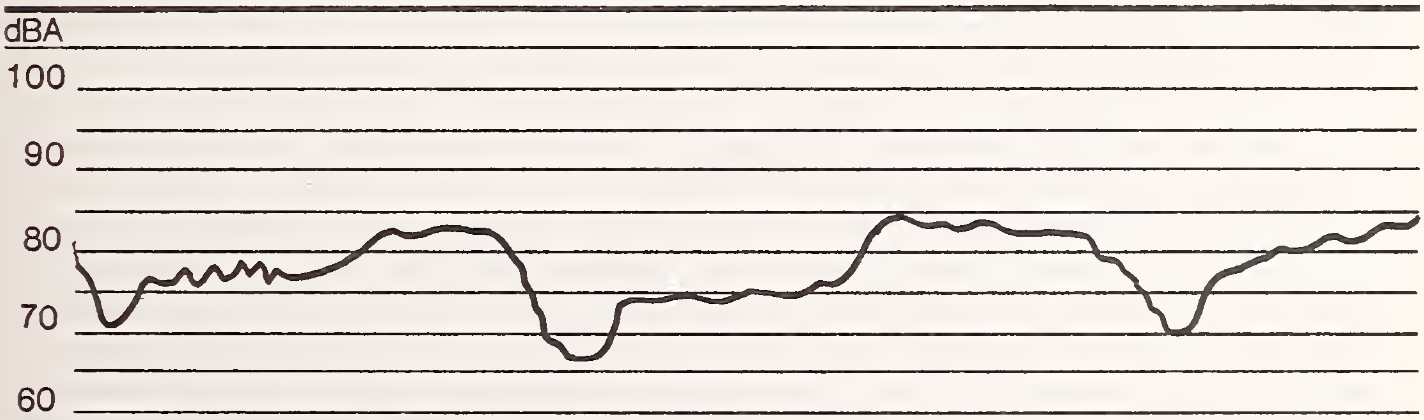
Geometry 

Track 

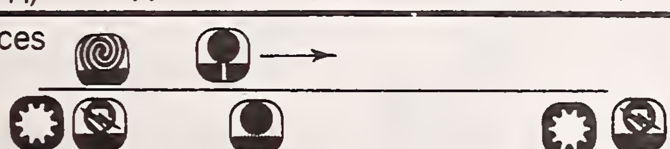
Station

SHERIDAN (A) ADDISON (B) BELMONT (A)





Speed (MPH)	17	25	0	18	24	0	24

Sources 

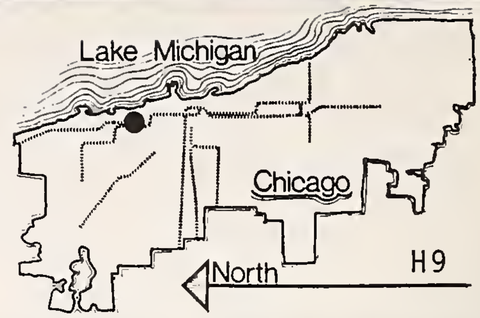
Paths 

IN-CAR NOISE MEASUREMENT

ROUTE: **HOWARD SERVICE**

SEGMENT: WELLINGTON AVE. - ARMITAGE AVE.

4 CAR 6000 SERIES



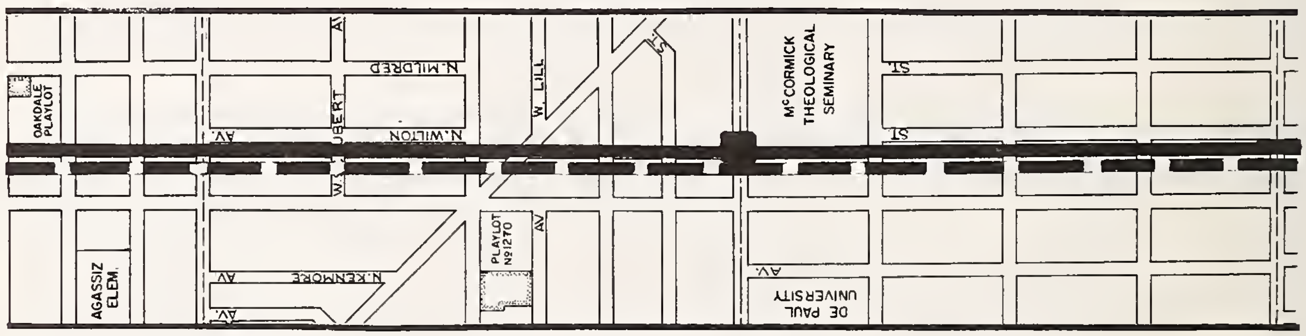
Structure

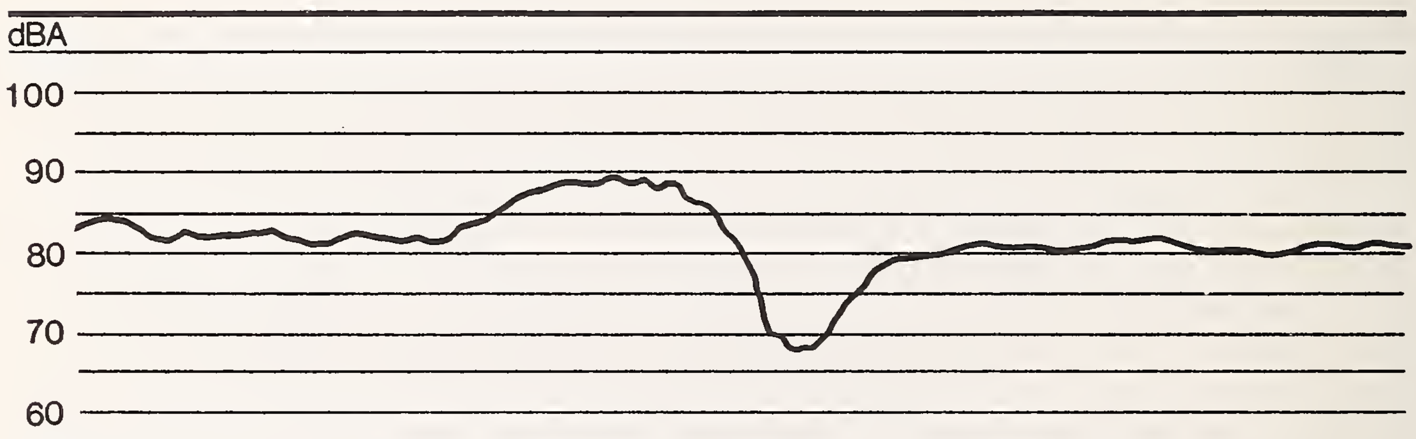
Geometry

Track

Station

FULLERTON (AB)





Speed (MPH) 24 32 0 20

Sources

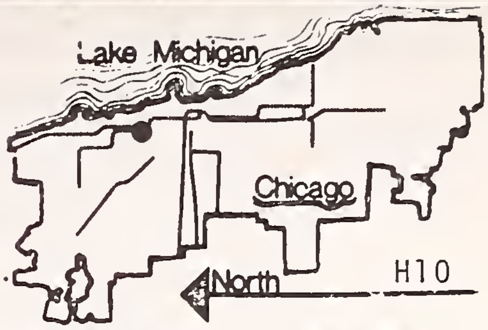
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: HOWARD SERVICE

SEGMENT: ARMITAGE AVE. - OGDEN AVE.

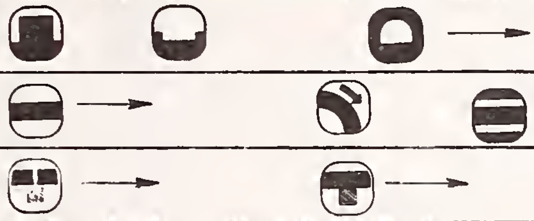
4 CAR 6000 SERIES



Structure

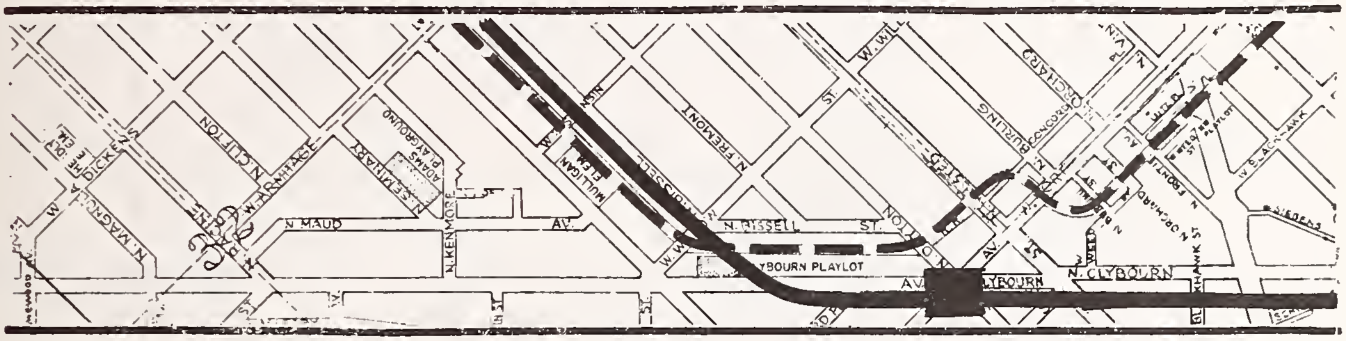
Geometry

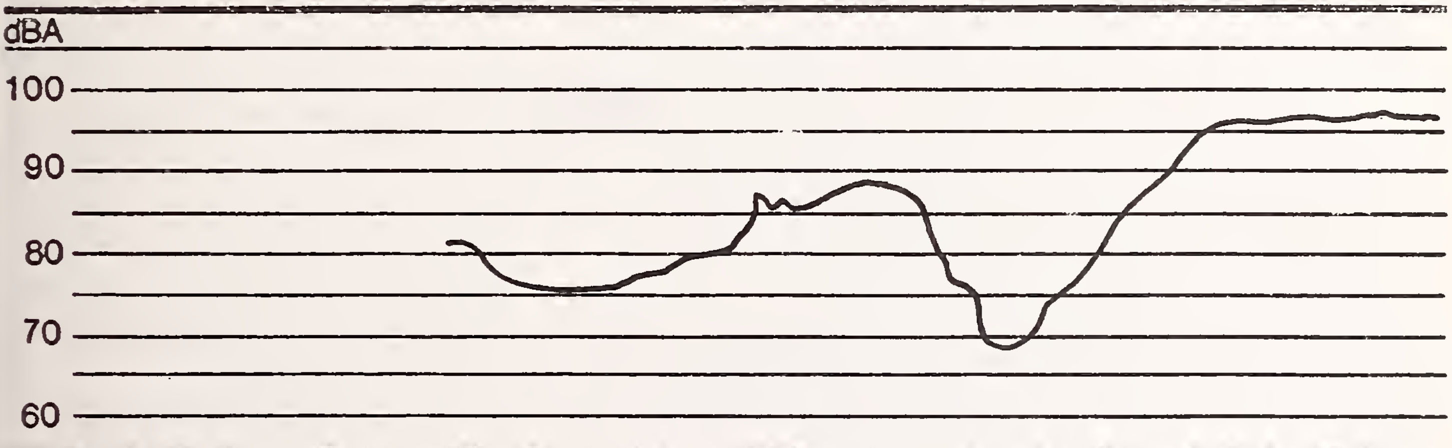
Track



Station

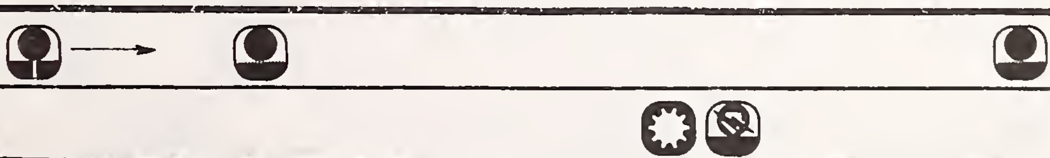
NORTH-CLYBORN (AB)



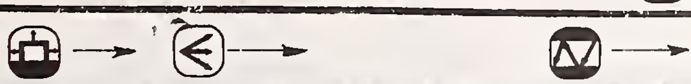


Speed (MPH) 20 30 0 30 40

Sources



Paths

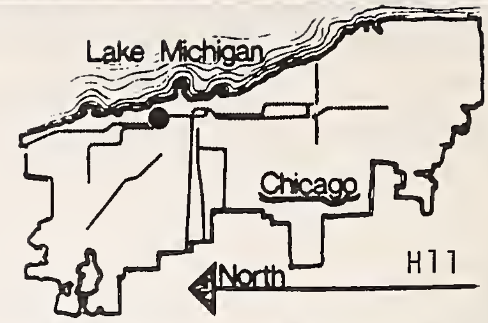


IN-CAR NOISE MEASUREMENT

ROUTE: HOWARD SERVICE

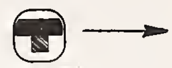
SEGMENT: OGDEN AVE. - CLARK ST.

4 CAR 6000 SERIES

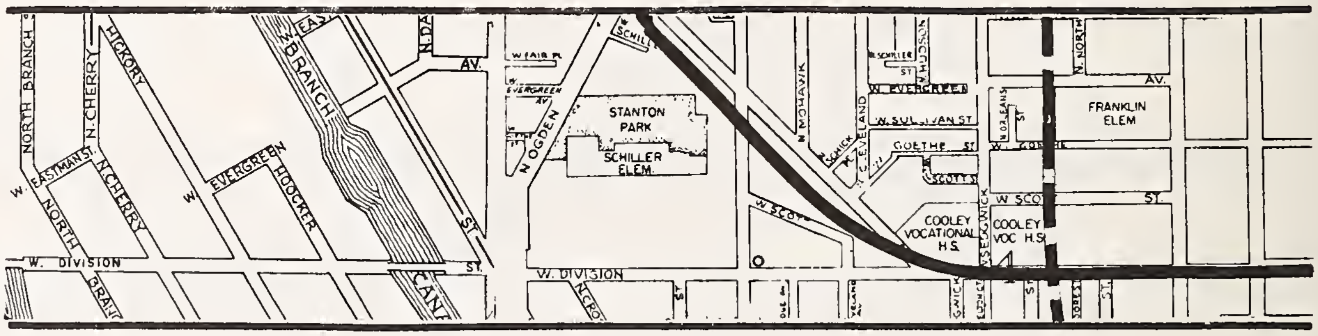


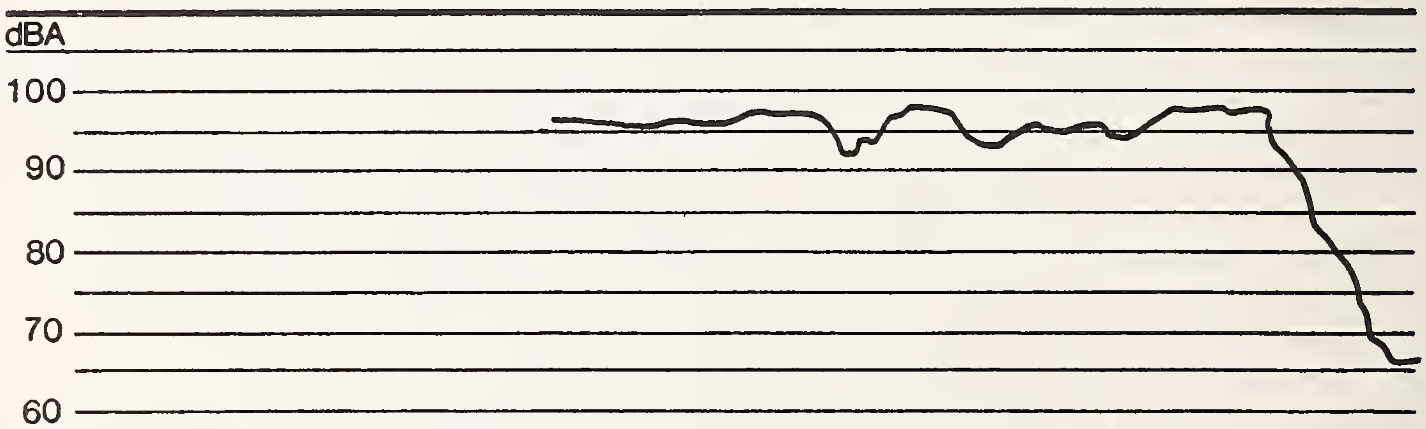
Structure 

Geometry 

Track 

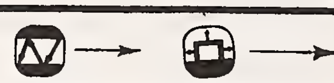
Station





Speed (MPH)	40	30	33	0

Sources 

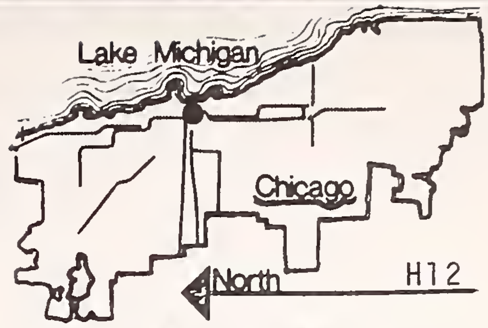
Paths 

IN-CAR NOISE MEASUREMENT

ROUTE: HOWARD SERVICE

SEGMENT: CLARK - HUBBARD ST.

4 CAR 6000 SERIES



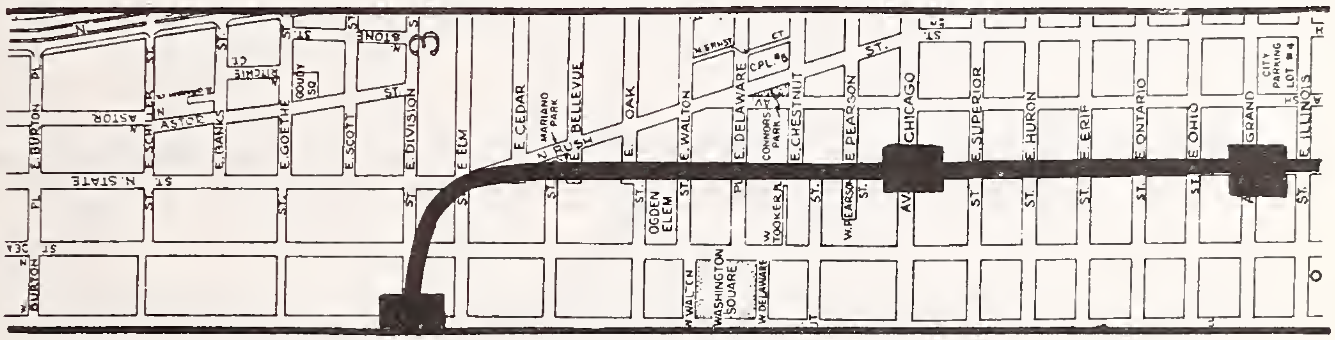
Structure

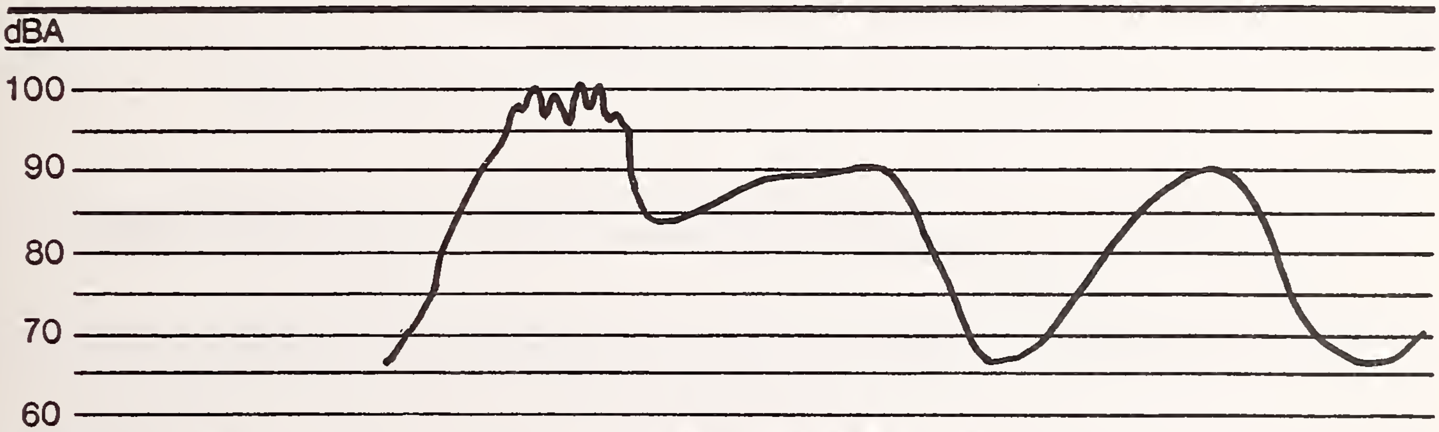
Geometry

Track

Station

CLARK-DIVISION (A) CHICAGO (AB) GRAND (AB)





Speed (MPH) 18 30 0 30 0

Sources

Paths

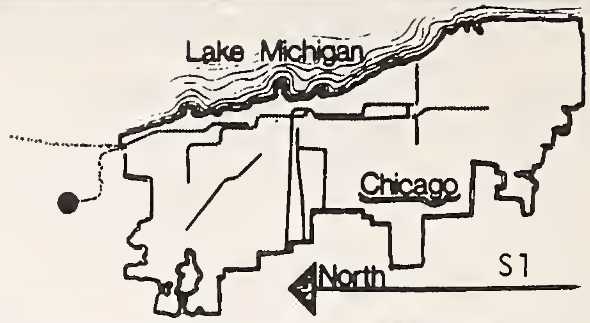
IN-CAR NOISE MEASUREMENT

ROUTE: SKOKIE SWIFT SERVICE

SEGMENT: DEMPSTER STATION - CICERO AVE.

1 CAR 6000 SERIES

SOAC 2



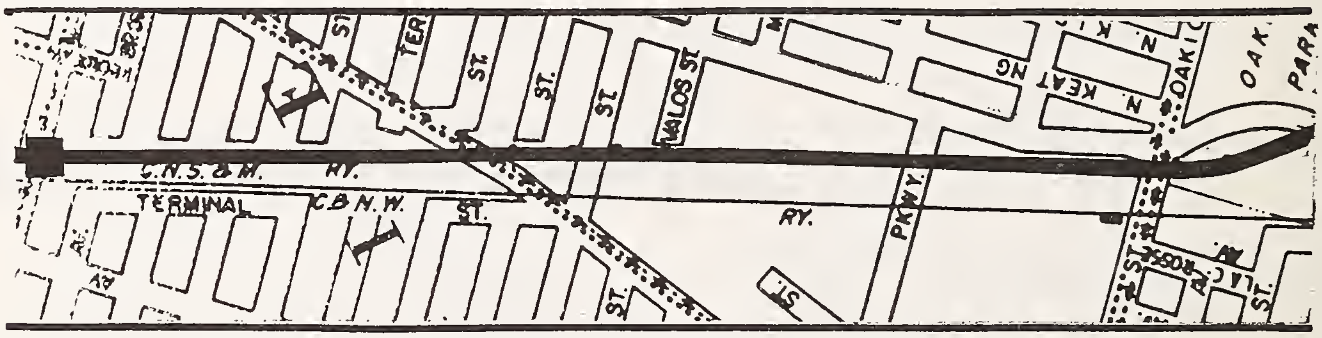
Structure

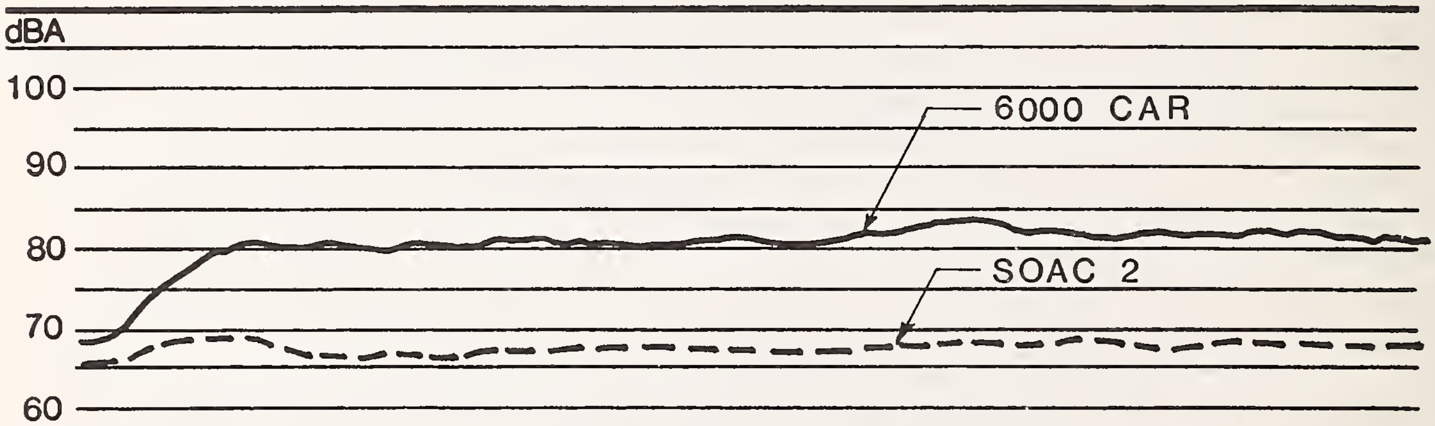
Geometry

Track

Station

DEMPSTER





Speed (MPH)							
	0	26	33	33	45	42	(6000)
	0	25	23	14	14	14	(SOAC)

Sources

Paths

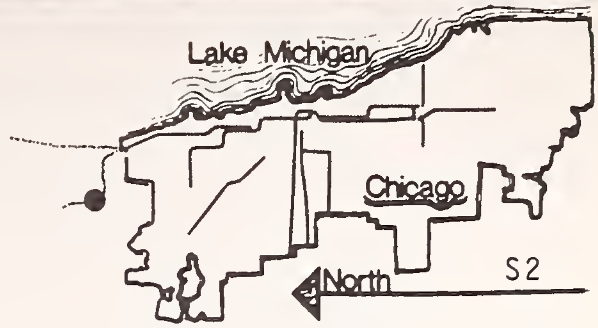
IN-CAR NOISE MEASUREMENT

ROUTE: SKOKIE SWIFT SERVICE

SEGMENT: CICERO AVE. - HAMLIN AVE.

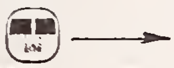
1 CAR 6000 SERIES

SOAC 2

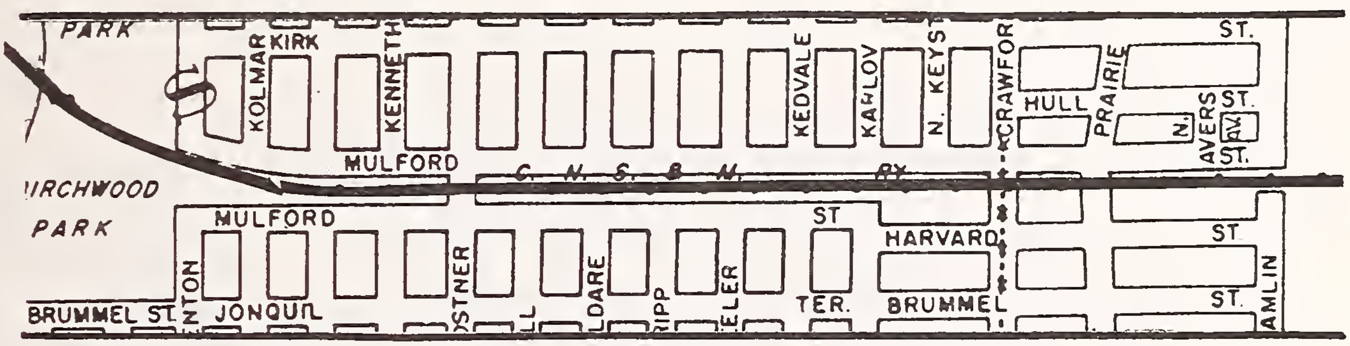


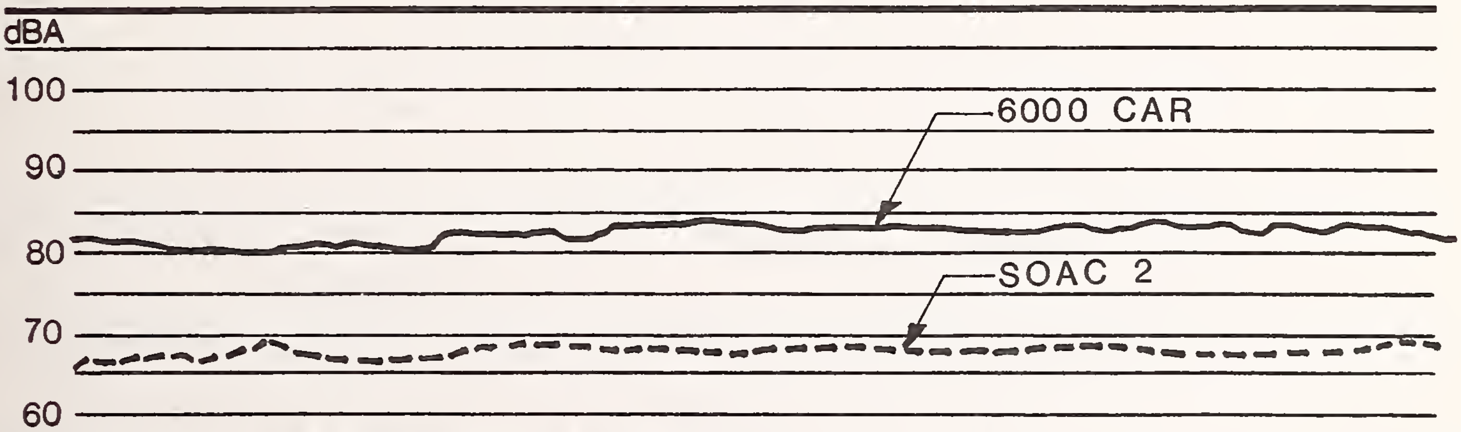
Structure 

Geometry 

Track 

Station





Speed (MPH)				
	30	45	47	39 (6000)
	23	31	50	48 (SOAC)

Sources 

Paths 

IN-CAR NOISE MEASUREMENT

ROUTE: SKOKIE SWIFT SERVICE

SEGMENT: HAMLIN AVE. - DODGE ST.

1 CAR 6000 SERIES

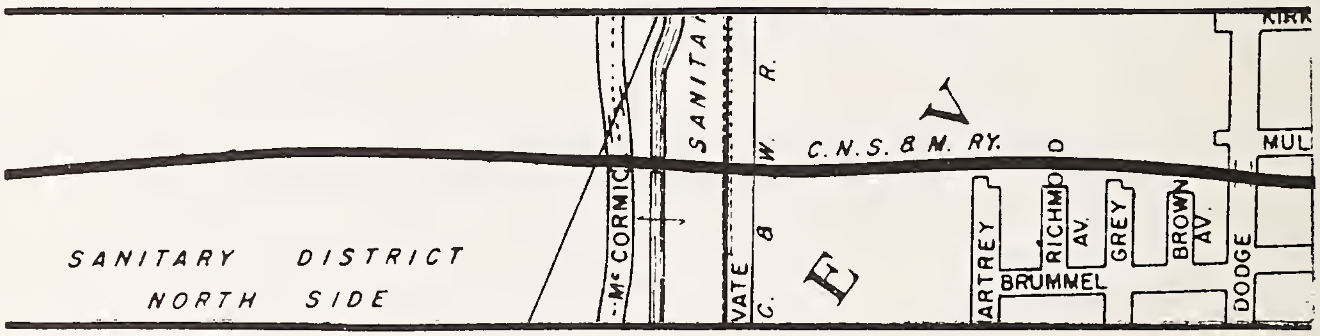
SOAC 2

Structure

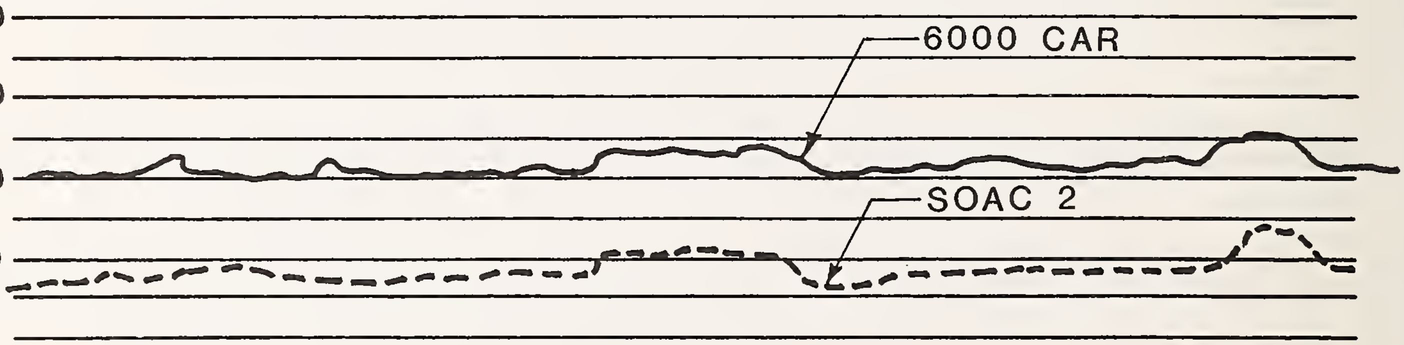
Geometry

Track

Station



dBA



Speed (MPH)	39 41	38 43	38 51	38 (6000) 57 (SOAC)

Sources

Paths

IN-CAR NOISE MEASUREMENT

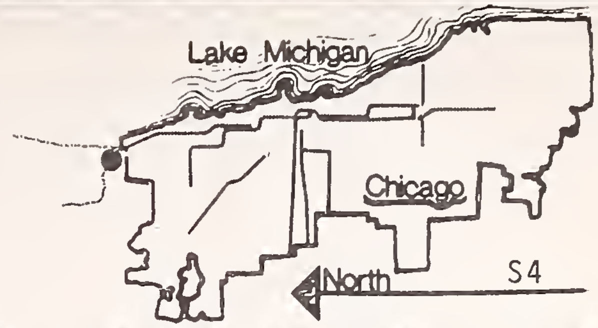
ROUTE: SKOKIE SWIFT SERVICE

SEGMENT:

DODGE ST. - HOWARD ST.

1 CAR 6000 SERIES

SOAC 2



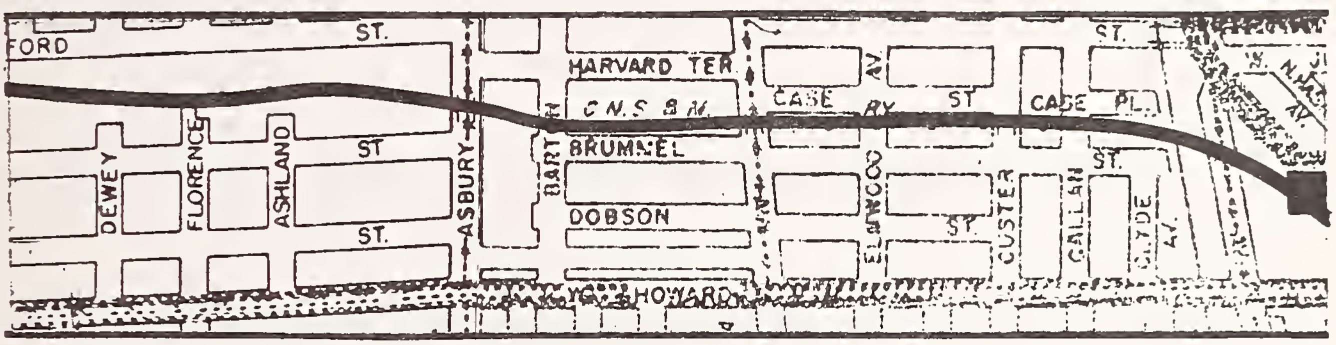
Structure

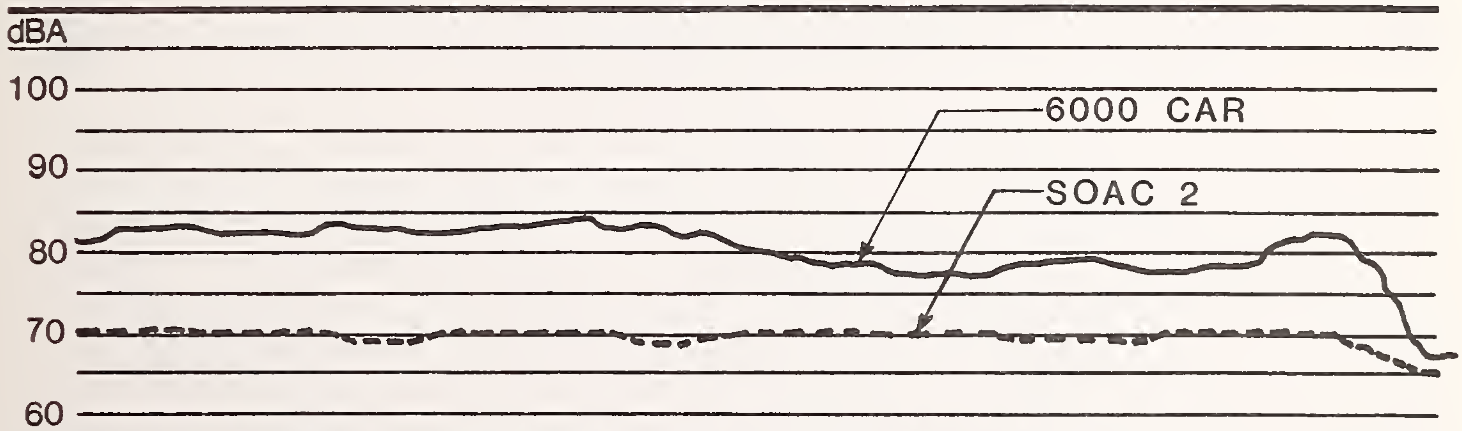
Geometry

Track

Station

HOWARD (AB)





Speed (MPH)	38	30	30	0
	57	50	35	0

Sources

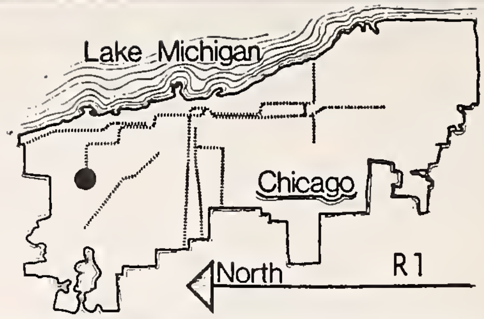
Paths

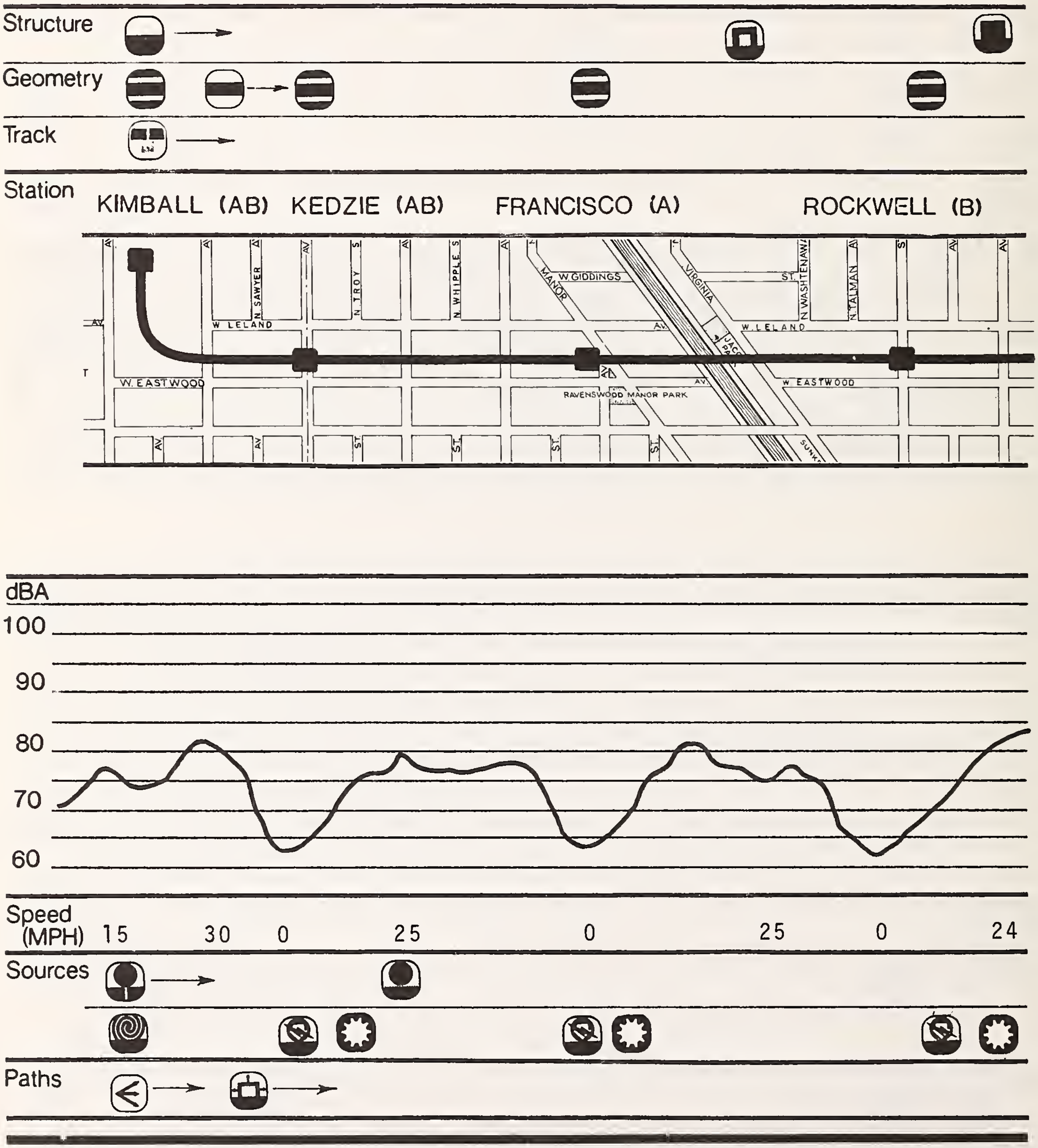
IN-CAR NOISE MEASUREMENT

ROUTE: RAVENSWOOD SERVICE

SEGMENT: KIMBALL AVE. - ARTESIAN AVE.

2 CAR 6000 SERIES



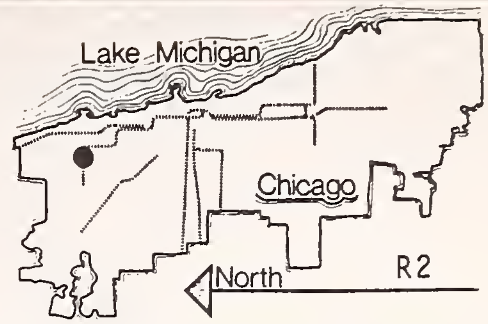


IN-CAR NOISE MEASUREMENT

ROUTE: RAVENSWOOD SERVICE

SEGMENT: ARTESIAN AVE. - WINDSOR AVE.

2 CAR 6000 SERIES

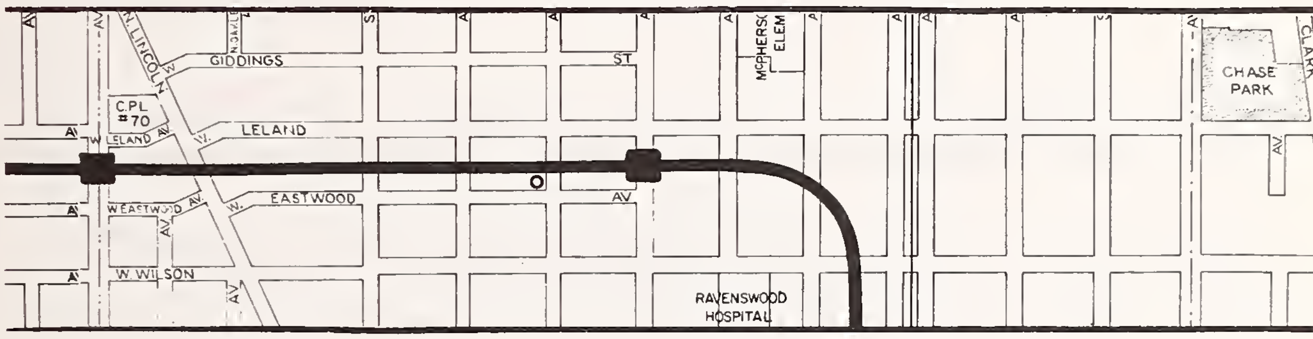


Structure

Geometry

Track

Station WESTERN (AB) DAMEN (A)



dBA

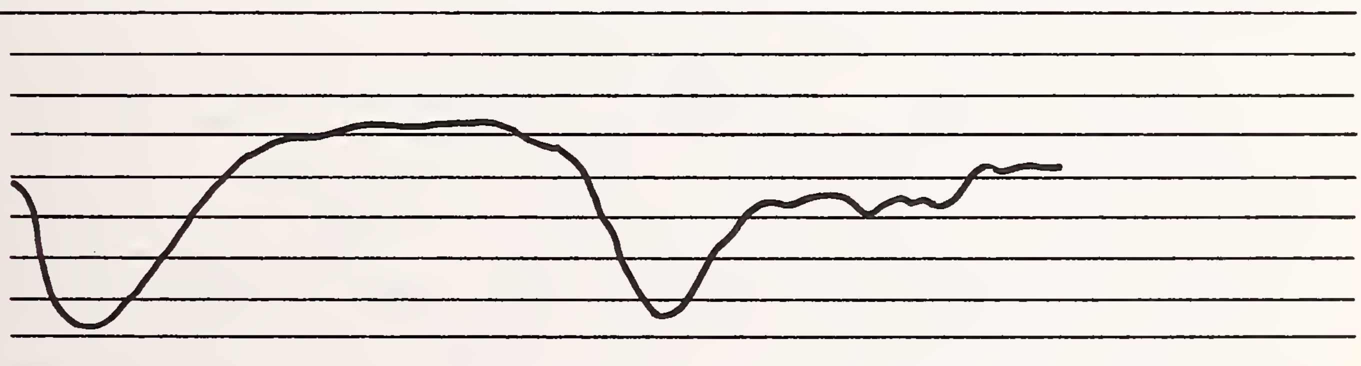
100

90

80

70

60



Speed (MPH) 0 33 0

Sources

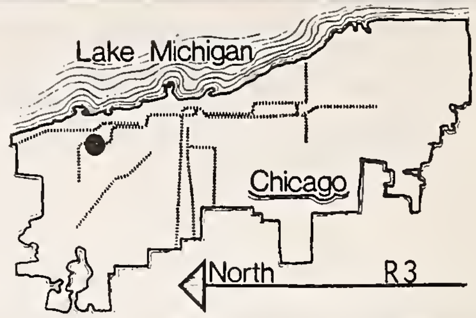
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: RAVENSWOOD SERVICE

SEGMENT: WINDSOR AVE. - ADDISON ST.

2 CAR 6000 SERIES

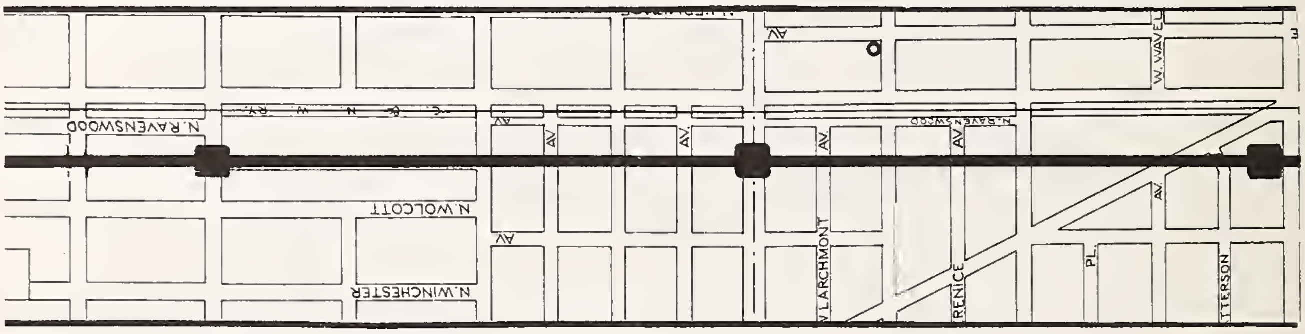


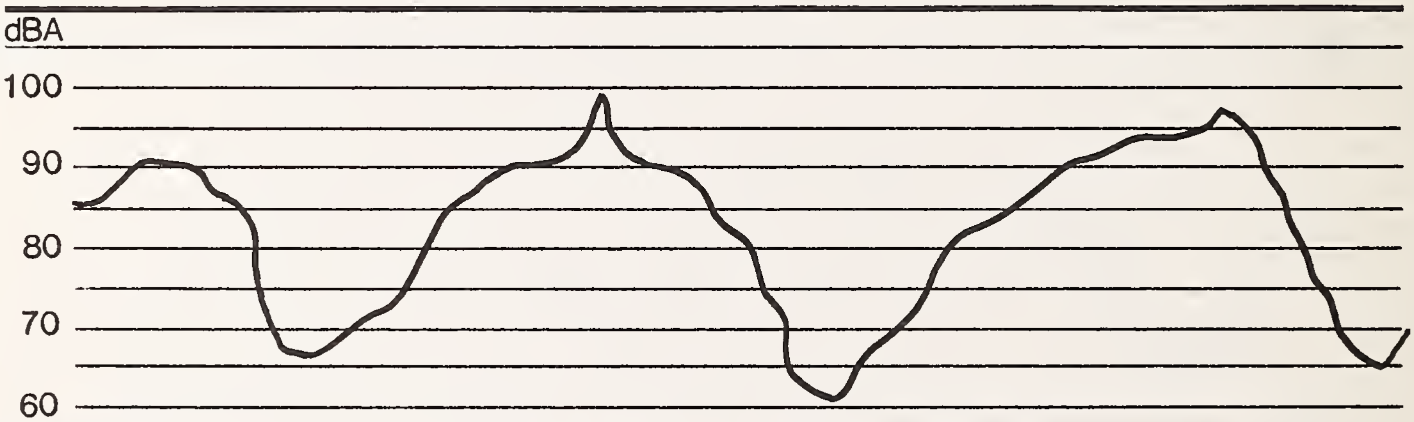
Structure

Geometry

Track

Station: MONTROSE (B) — IRVING PARK (AB) — ADDISON (A)





Speed (MPH): 32 0 33 0 35 0

Sources

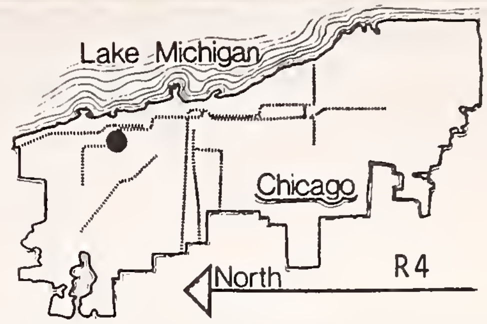
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **RAVENSWOOD SERVICE**

SEGMENT: ADDISON ST. - BUCKINGHAM ST.

2 CAR 6000 SERIES



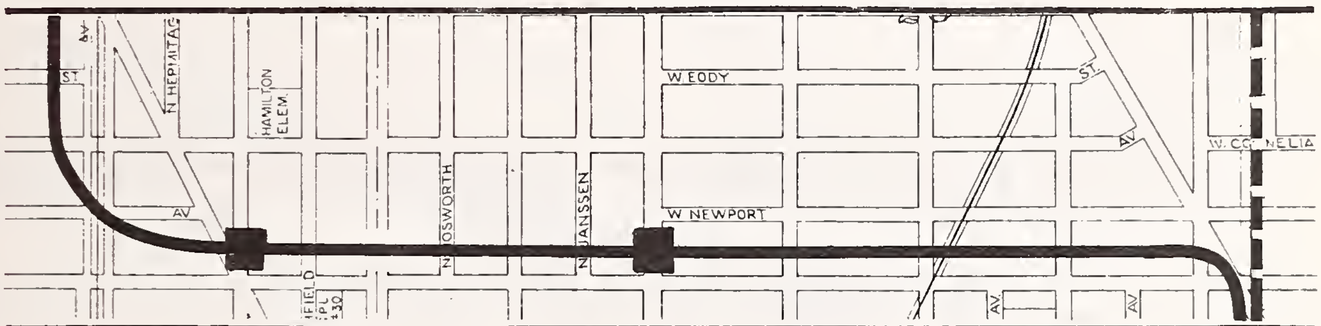
Structure

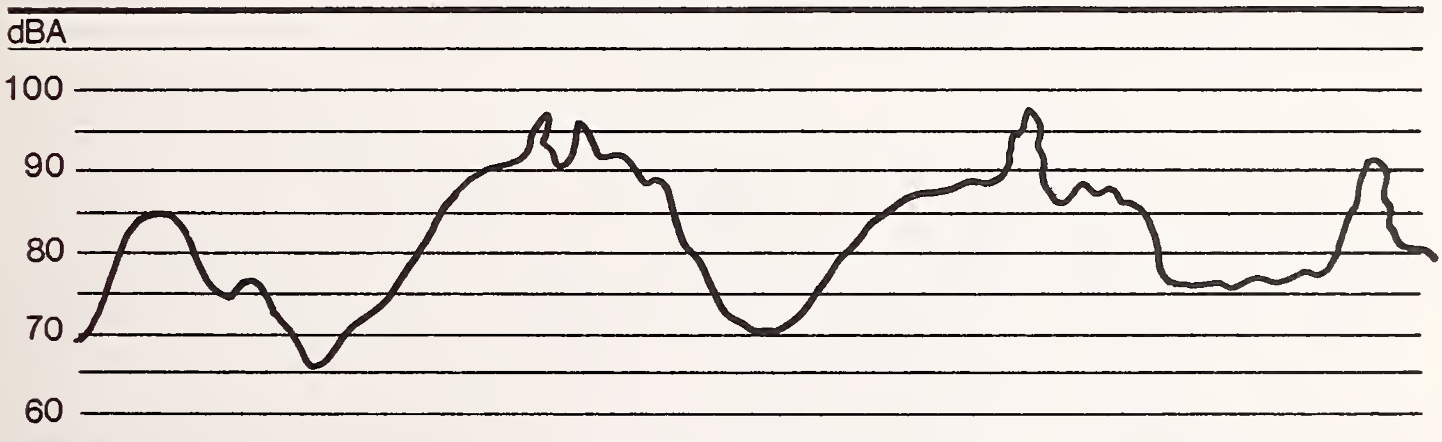
Geometry

Track

Station

PAULINA (A) SOUTHPORT (B)





Speed (MPH) 25 12 0 34 0 30 18 20

Sources

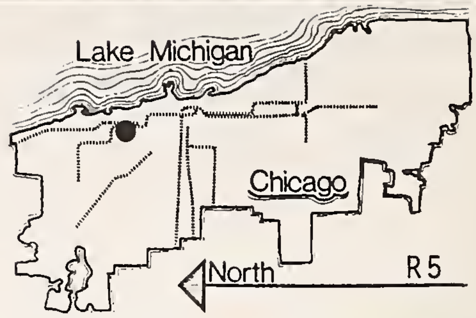
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **RAVENSWOOD SERVICE**

SEGMENT: BUCKINGHAM ST. - FULLERTON AVE.

2 CAR 6000 SERIES



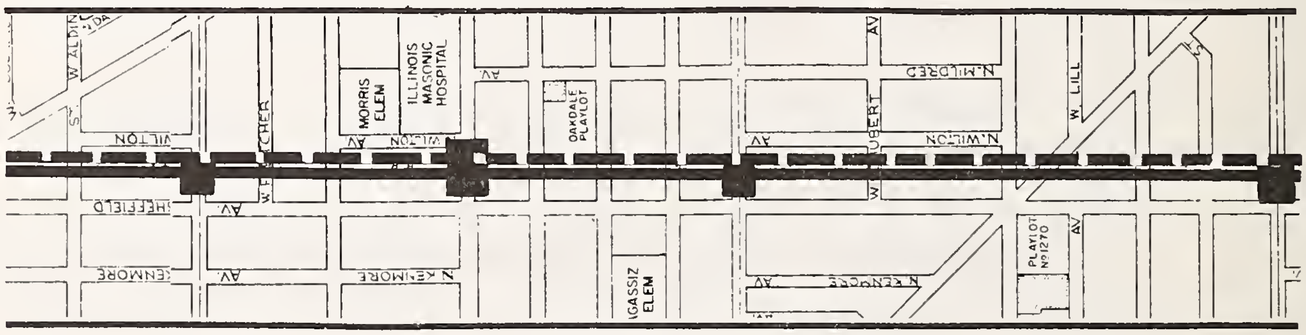
Structure

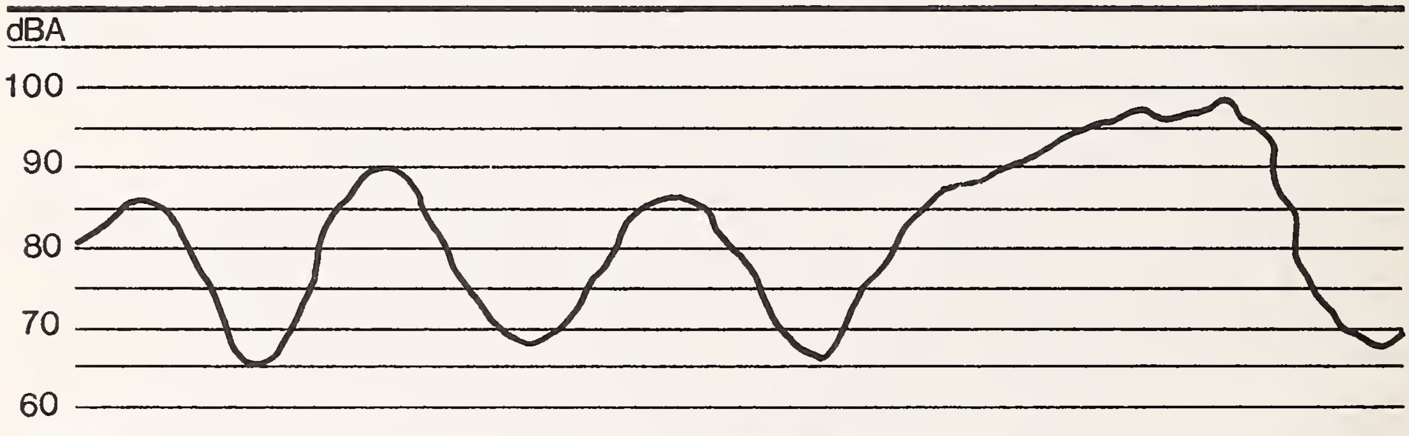
Geometry

Track

Station

BELMONT (AB) WELLINGTON (A) DIVERSEY (B) FULLERTON (AB)





Speed (MPH) 26 0 30 0 30 0 30 40

Sources

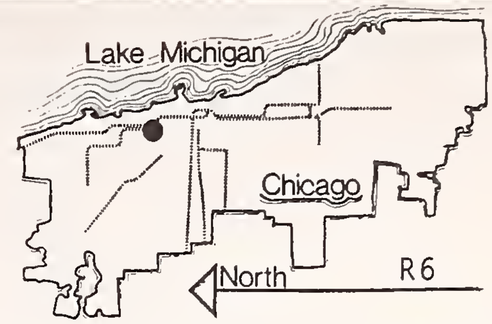
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: RAVENSWOOD SERVICE

SEGMENT: FULLERTON AVE. - CLEVELAND AVE.

2 CAR 6000 SERIES



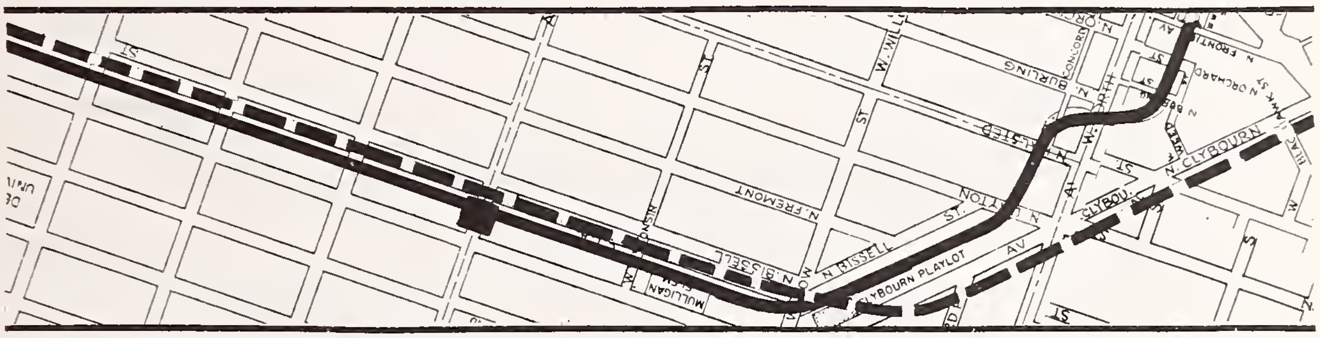
Structure

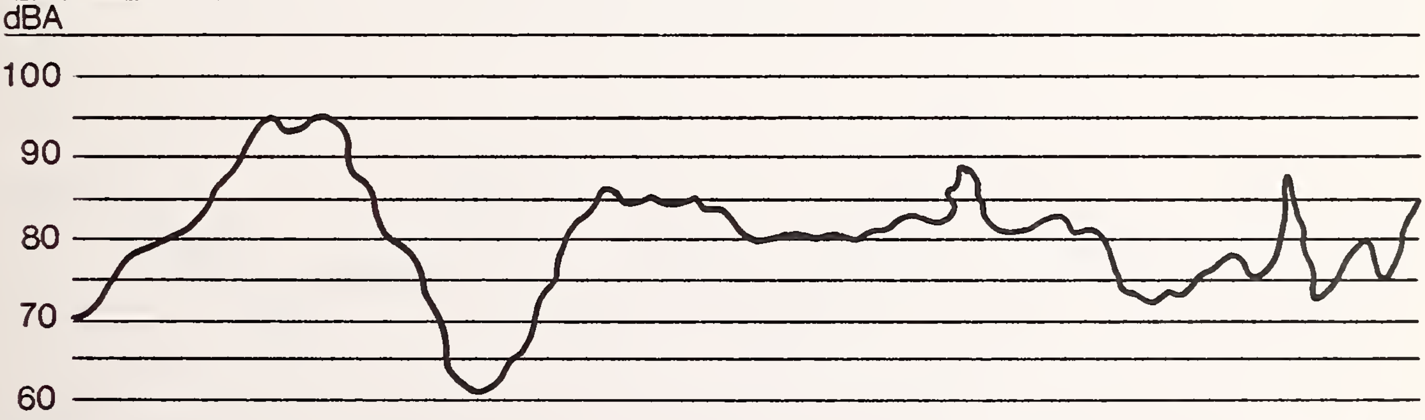
Geometry

Track

Station

ARMITAGE (A)





Speed (MPH) 35 0 30 27 12

Sources

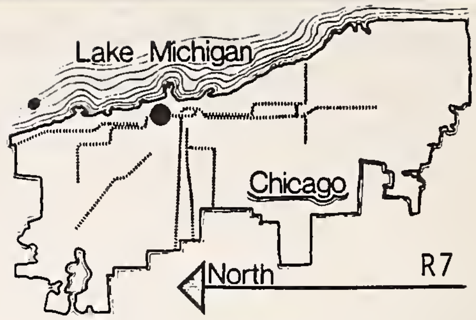
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **RAVENSWOOD SERVICE**

SEGMENT: CLEVELAND AVE. - OHIO ST.

2 CAR 6000 SERIES



Structure

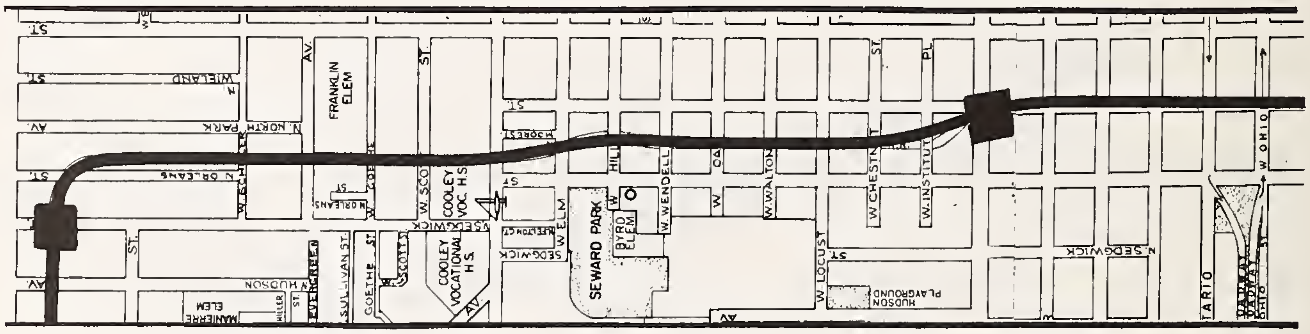
Geometry

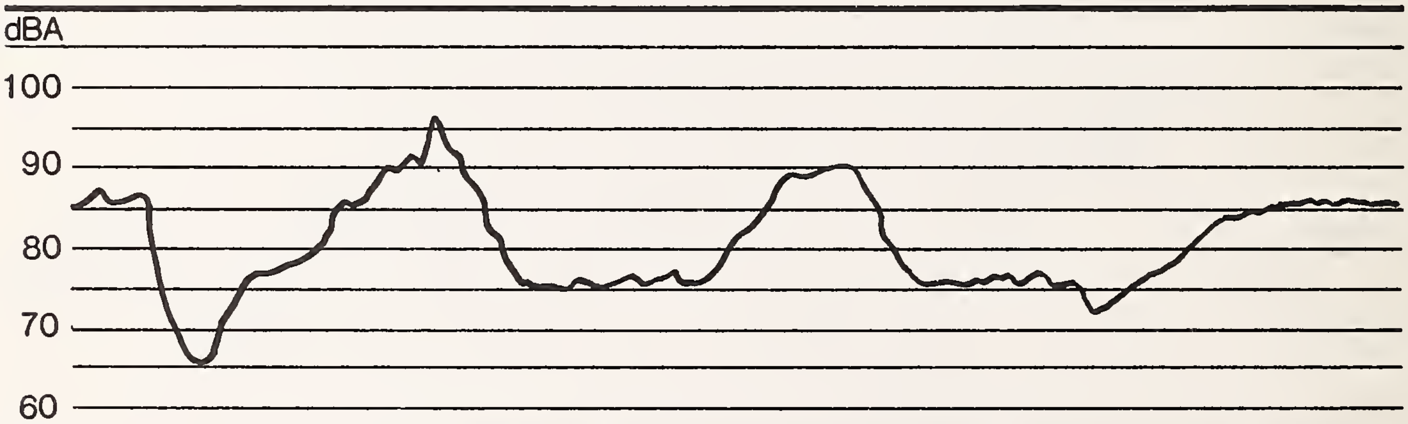
Track

Station

SEDGWICK (B)

CHICAGO (AB)





Speed (MPH) 0 35 15 33 17 33

Sources

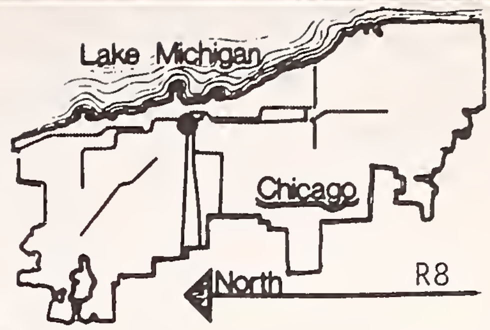
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: RAVENSWOOD SERVICE

SEGMENT: OHIO ST. - LA SALLE ST.

2 CAR 6000 SERIES



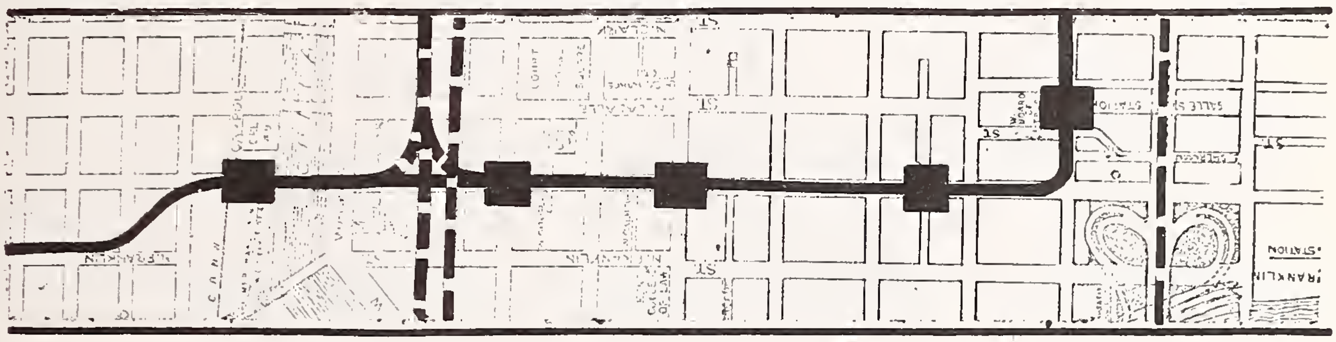
Structure

Geometry

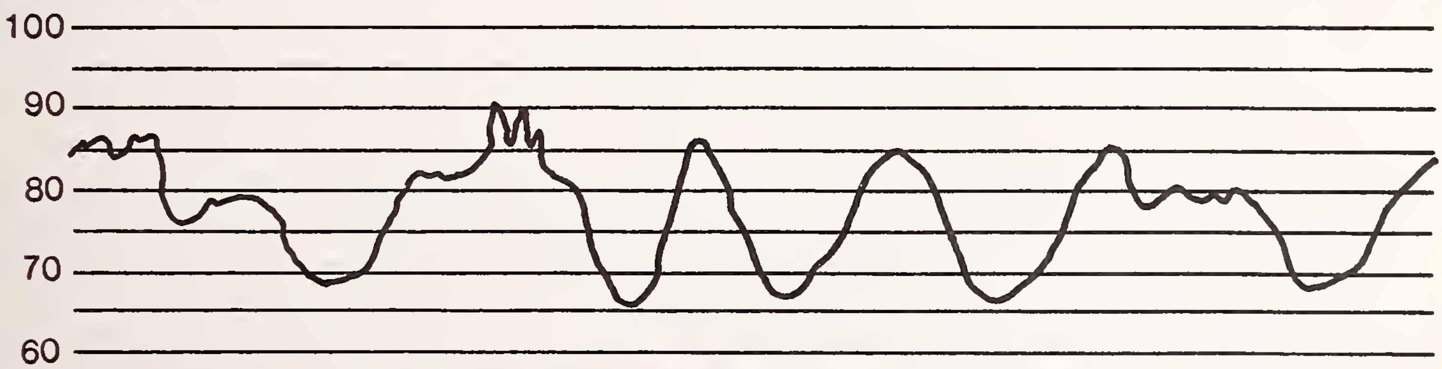
Track

Station

MERCH. MART RANDOLPH MADISON QUINCY LA SALLE



dBA



Speed (MPH)	0	16	0	30	0	30	0	30	0	30	16	0	30

Sources

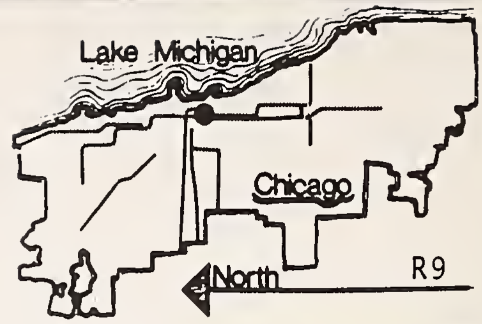
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: RAVENSWOOD SERVICE

SEGMENT: LA SALLE ST. - WABASH AVE.

2 CAR 6000 SERIES



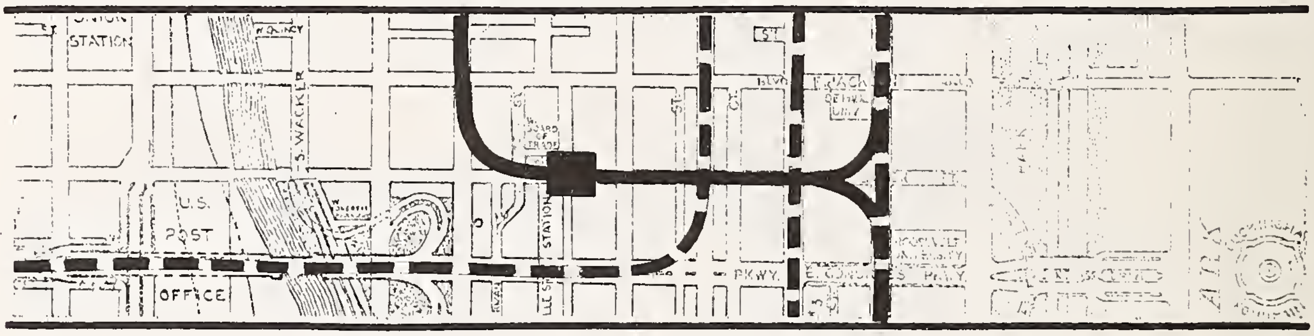
Structure

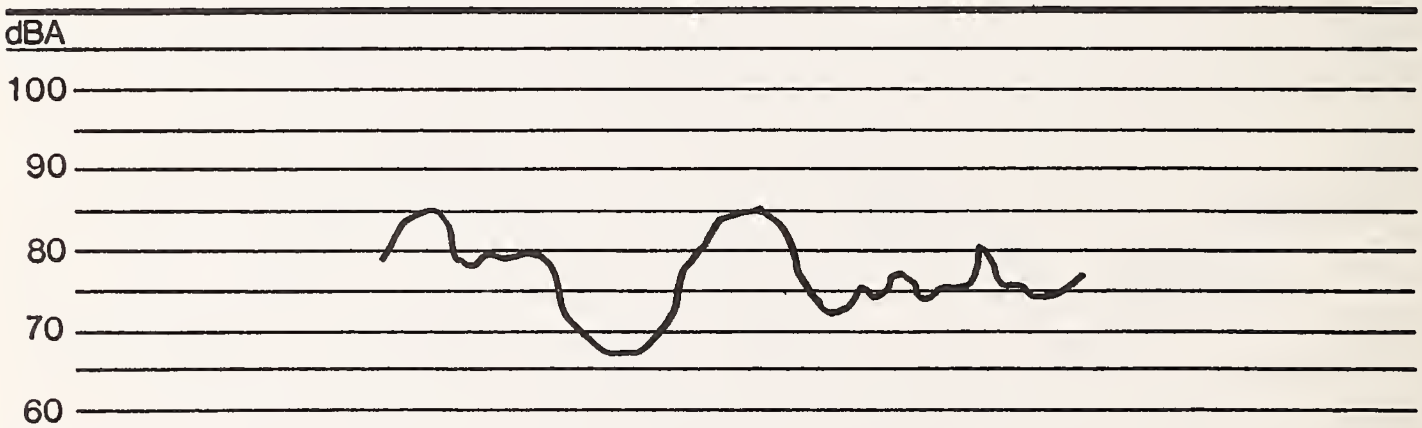
Geometry

Track

Station

LA SALLE (AB)





Speed (MPH) 30 16 0 30 12

Sources

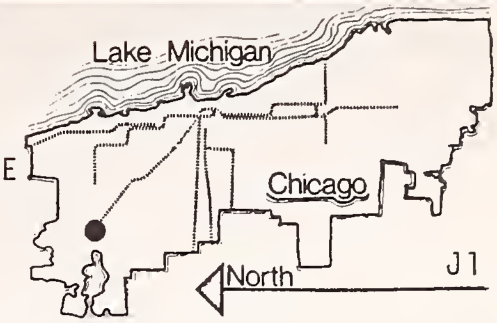
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT: JEFFERSON PARK STATION - LA PORTE AVE

2 CAR 6000 SERIES



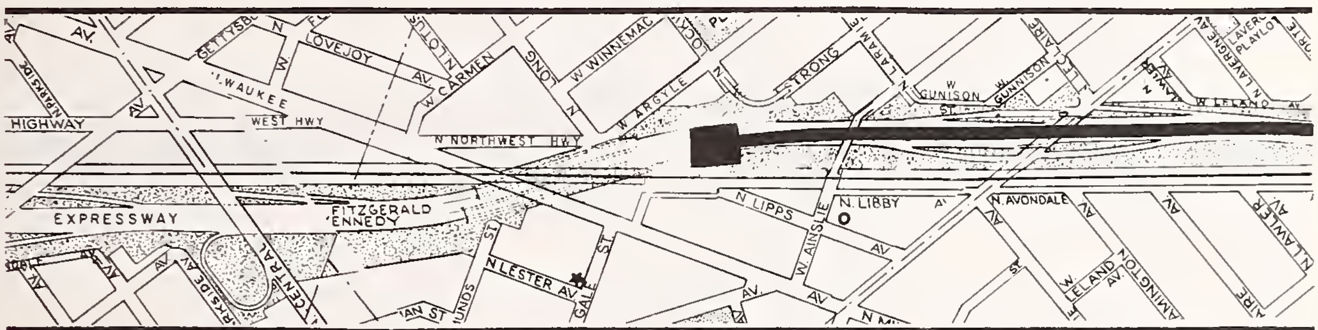
Structure 

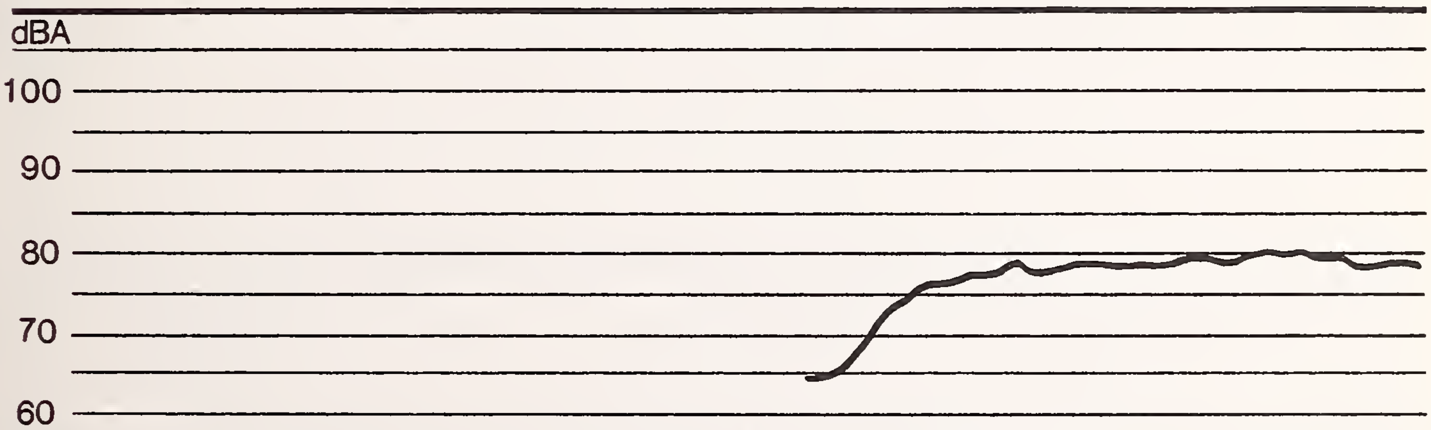
Geometry 

Track 

Station

JEFFERSON PARK (AB)





Speed (MPH) 0 24

Sources

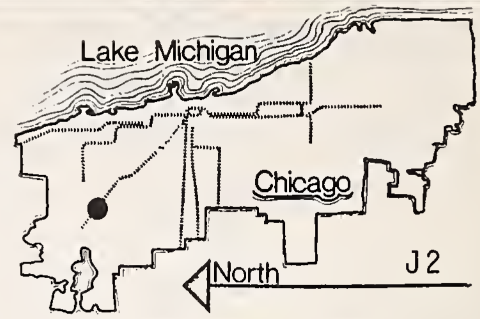
Paths 

IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT: LA PORTE AVE. - TRIPP AVE.

2 CAR 6000 SERIES



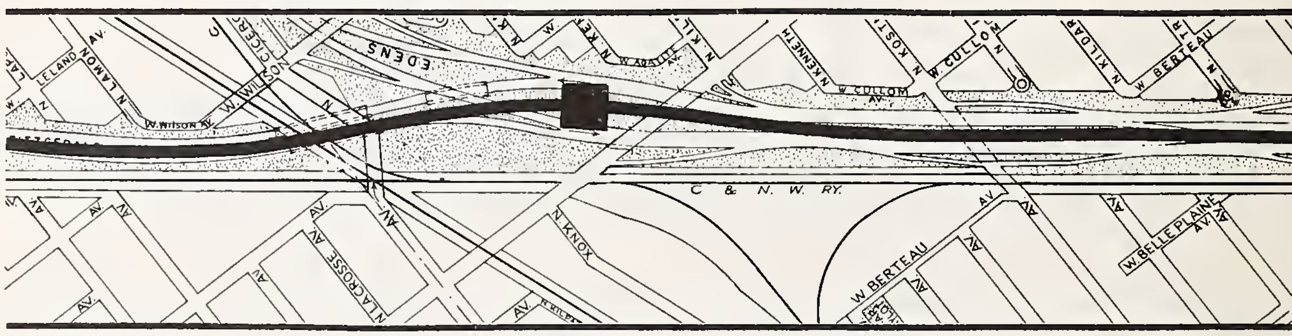
Structure

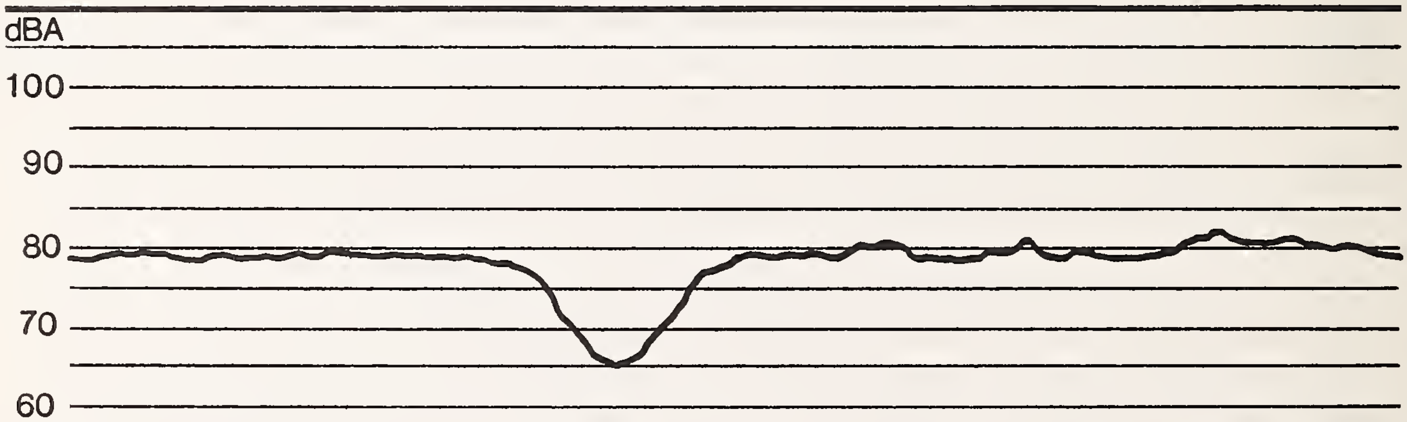
Geometry

Track

Station

MONTROSE (A)





Speed (MPH) 35 0 37

Sources

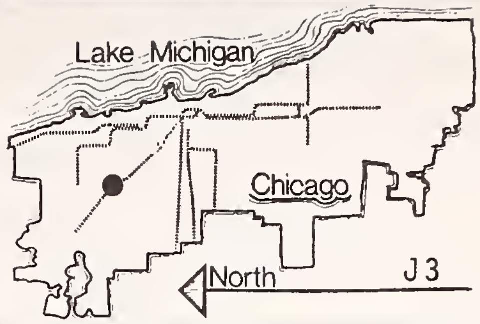
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT: TRIPP AVE. - CENTRAL PARK AVE.

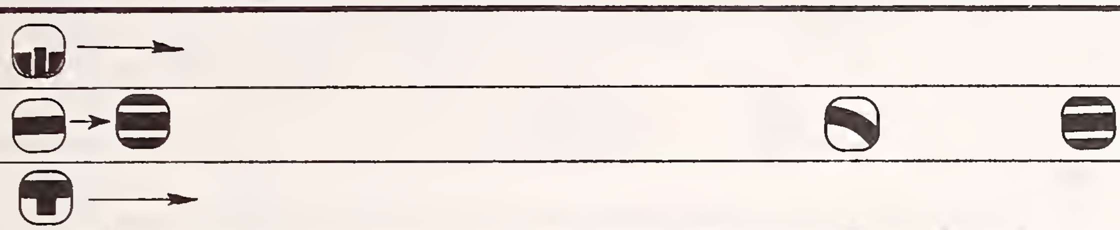
2 CAR 6000 SERIES



Structure

Geometry

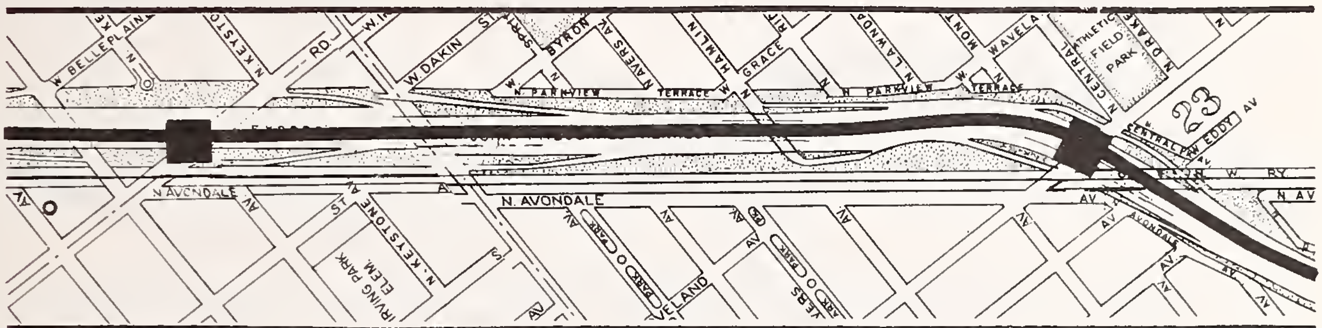
Track

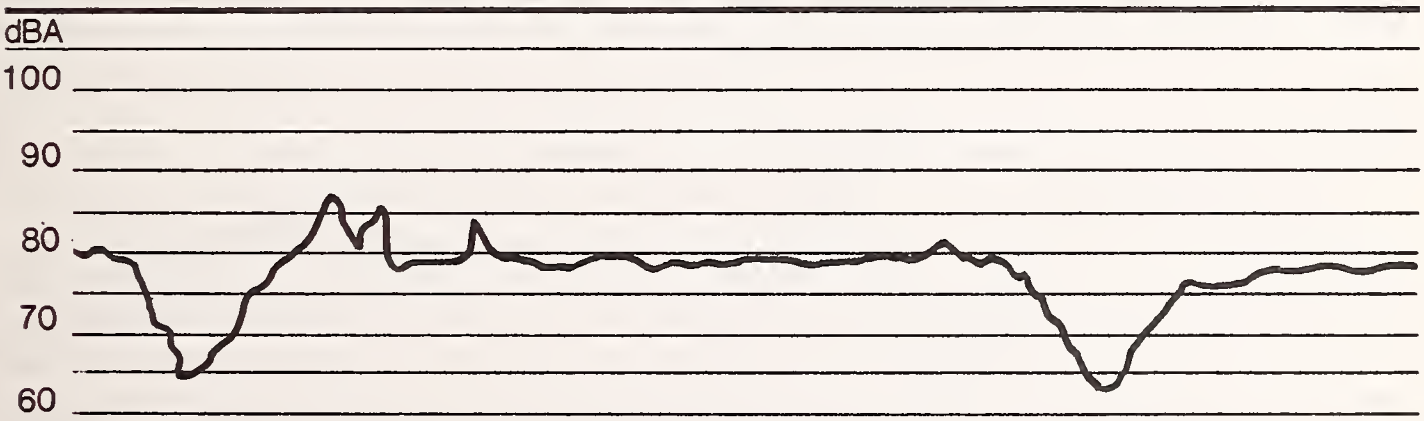


Station

IRVING PARK (B)

ADDISON (A)





Speed (MPH) 0 34 34 0 30

Sources

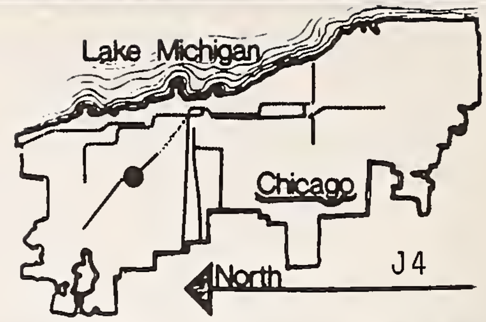
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT: CENTRAL PARK AVE.- LOGAN SQUARE

2 CAR 2000 SERIES



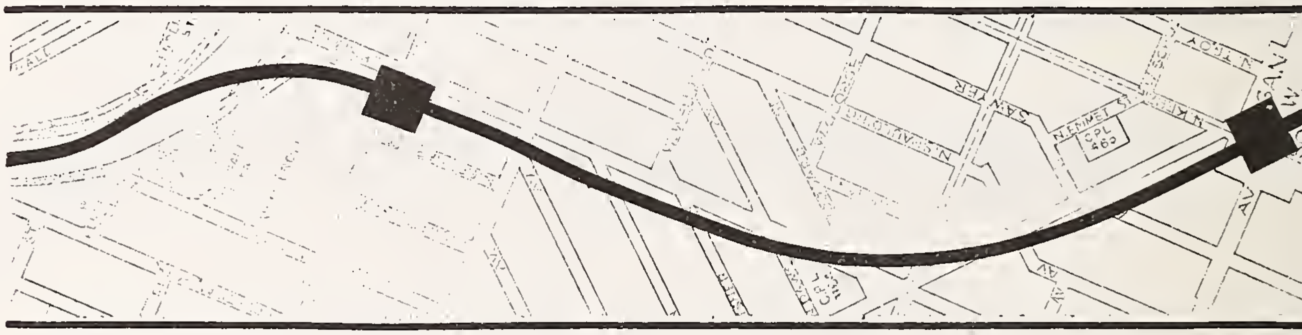
Structure

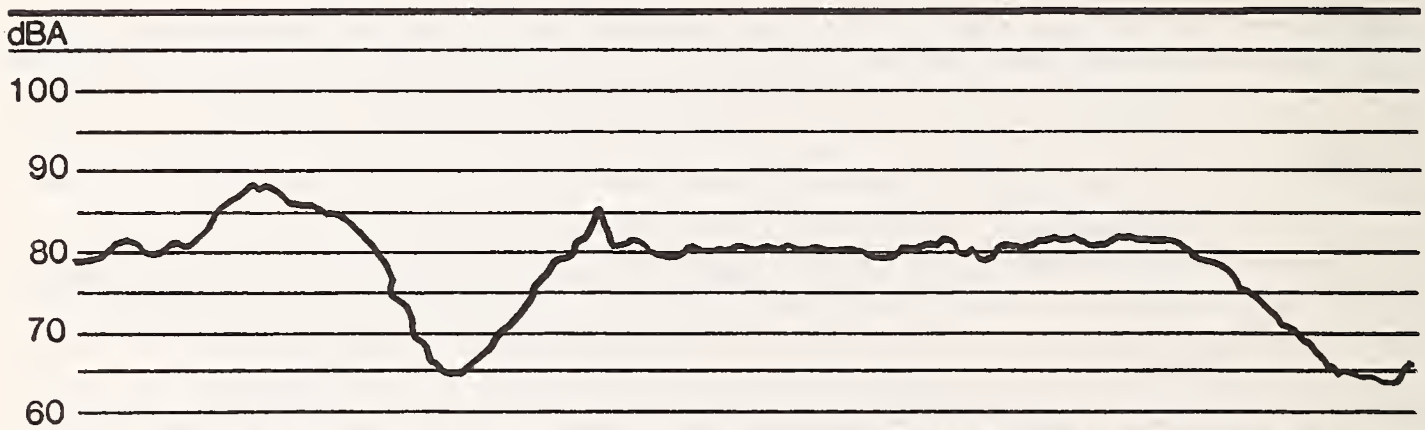
Geometry

Track

Station

BELMONT (B) LOGAN SQUARE (AB)





Speed (MPH) 31 0 30 30 25 0

Sources

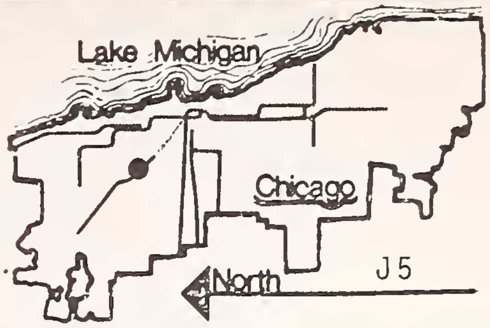
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

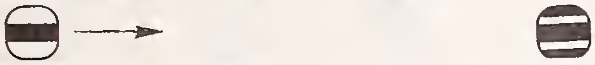
SEGMENT: LOGAN SQUARE - WESTERN STATION

2 CAR 6000 SERIES

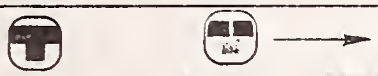


Structure

Geometry

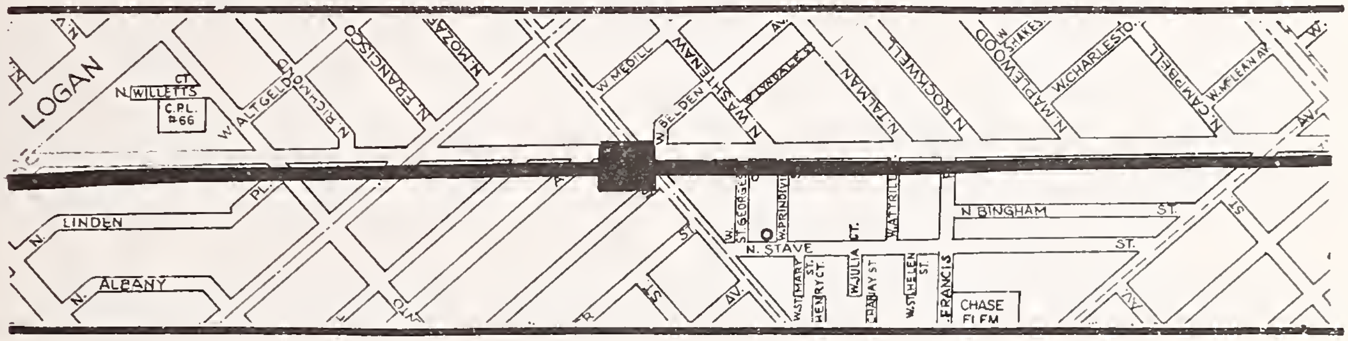


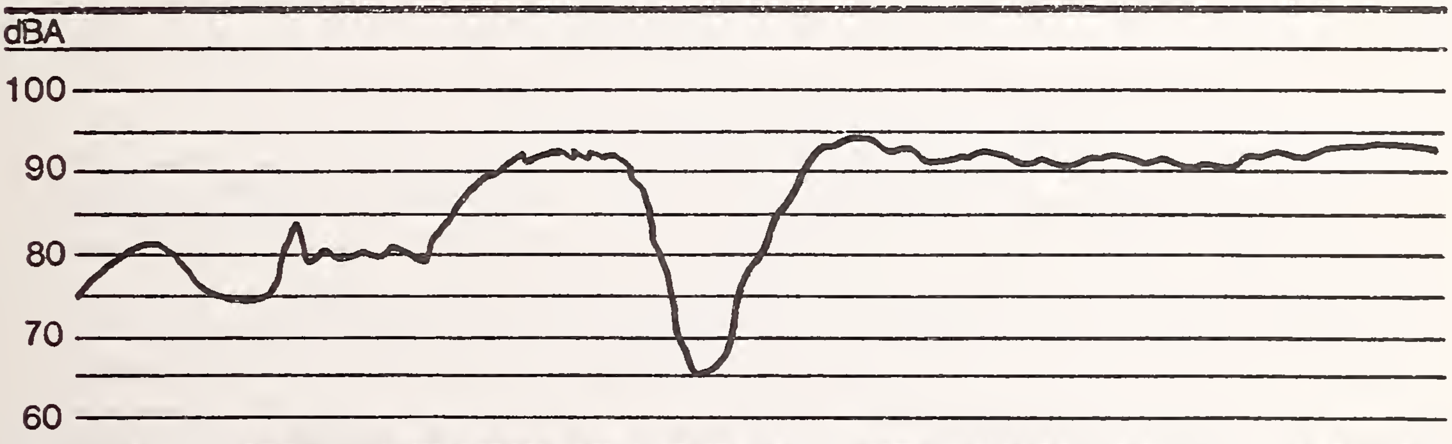
Track



Station

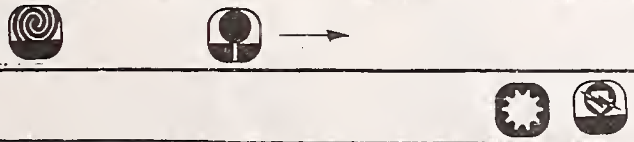
CALIFORNIA (A)





Speed (MPH) 25 28 35 0 33

Sources



Paths

IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

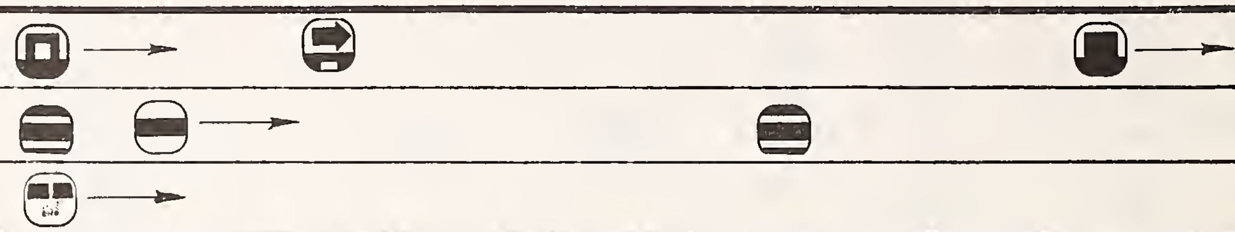
SEGMENT: WESTERN STATION - HERMITAGE AVE.

2 CAR 6000 SERIES

Structure

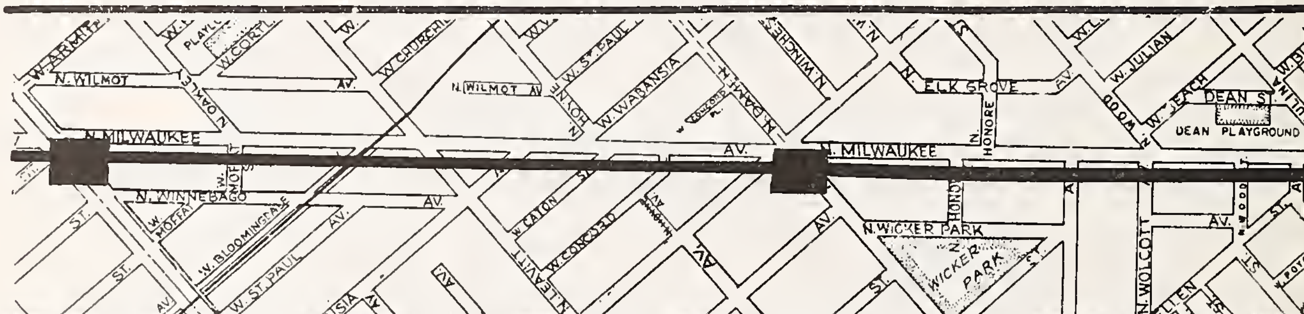
Geometry

Track

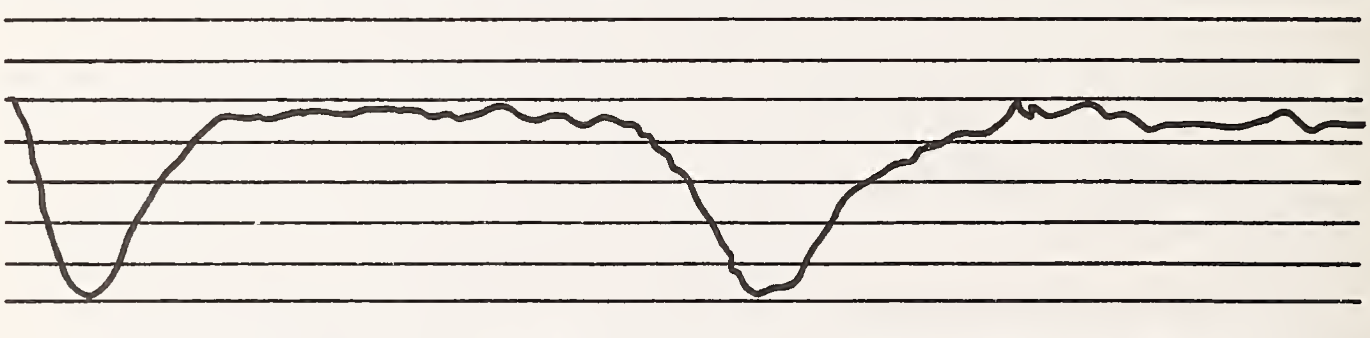


Station

WESTERN (B) DAMEN (AB)



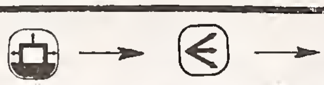
dBA



Speed (MPH) 0 33 0 30

Sources

Paths

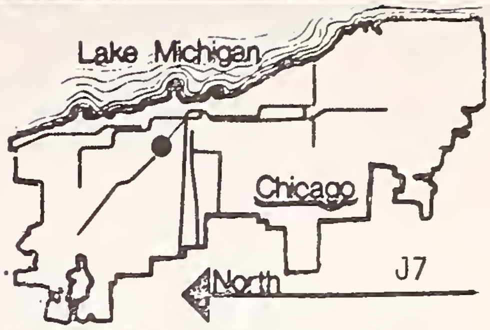


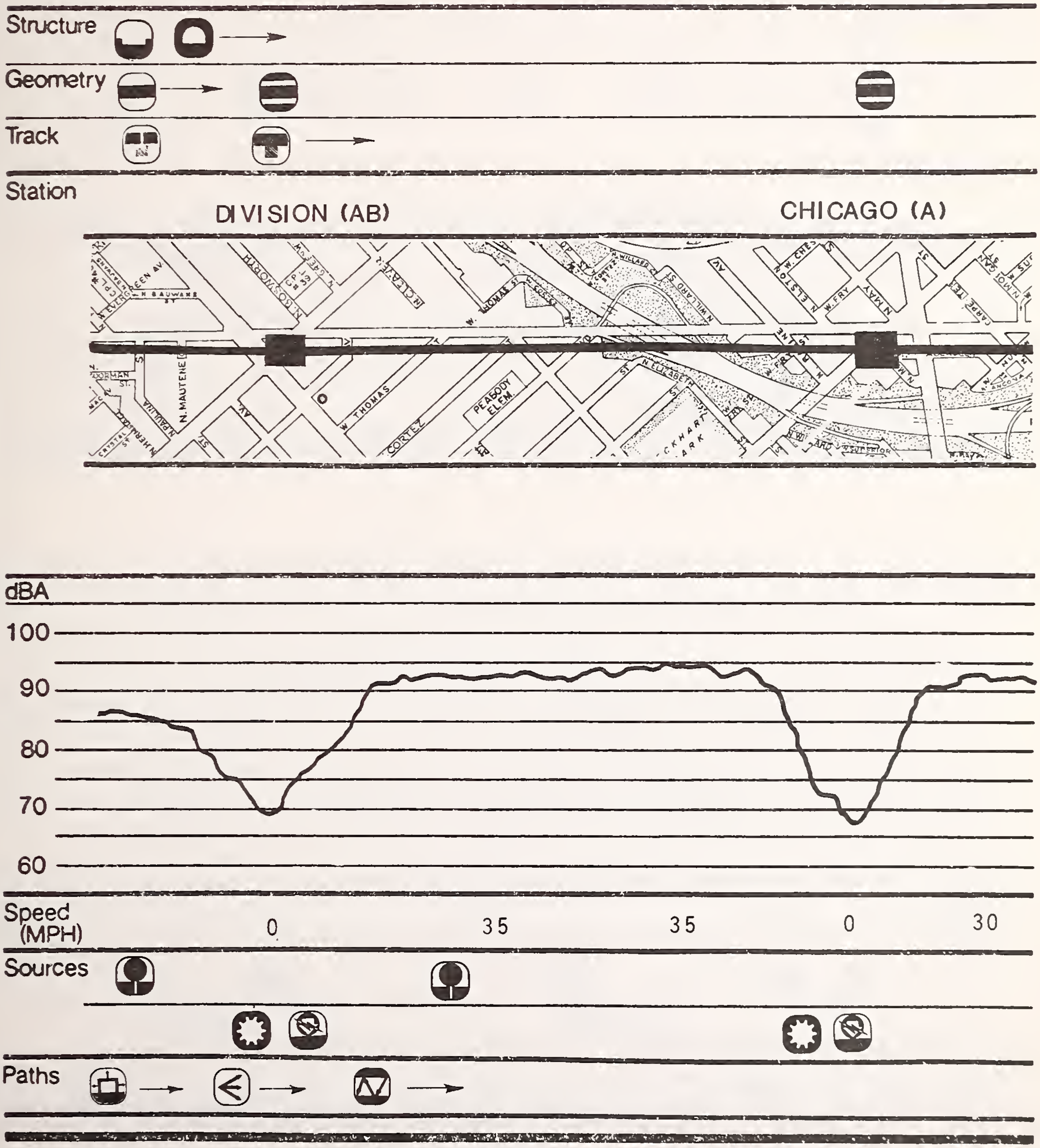
IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT: HERMITAGE AVE. - HURON ST.

2 CAR 6000 SERIES



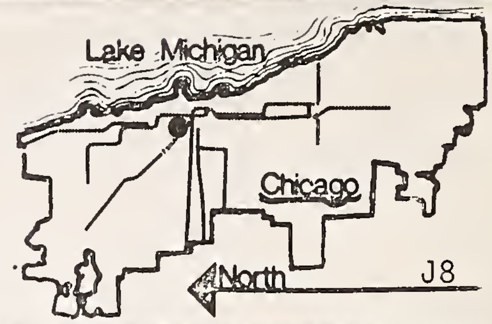


IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT: HURON ST. - FRANKLIN ST.

2 CAR 6000 SERIES



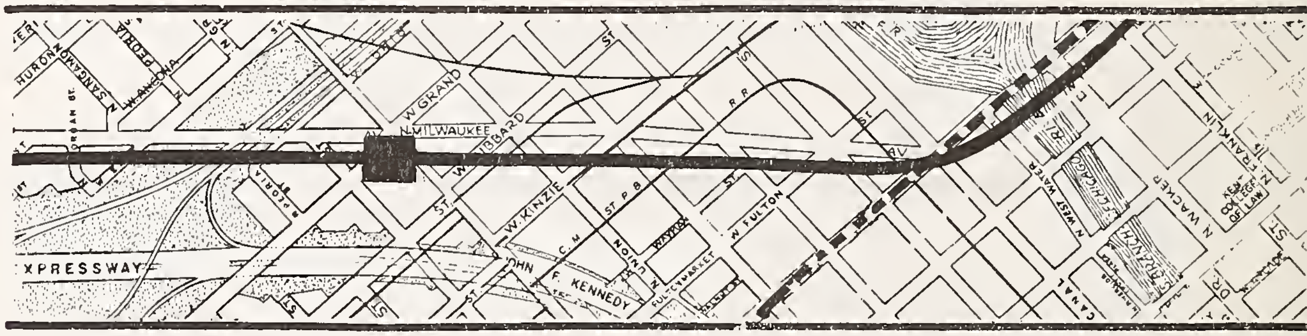
Structure

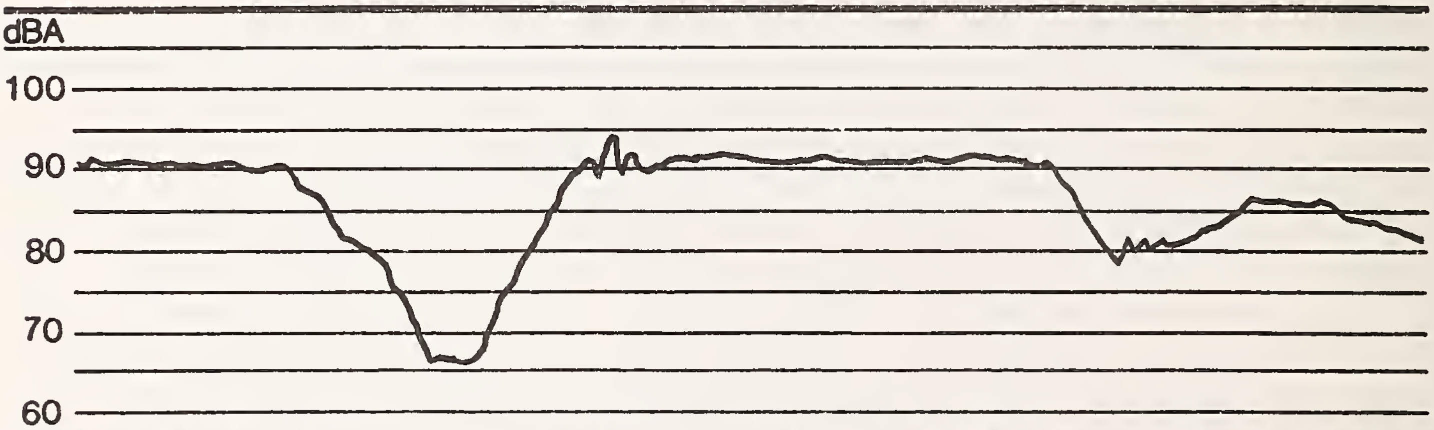
Geometry

Track

Station

GRAND (B)





Speed (MPH)	30	0	30	25	20

Sources

Paths

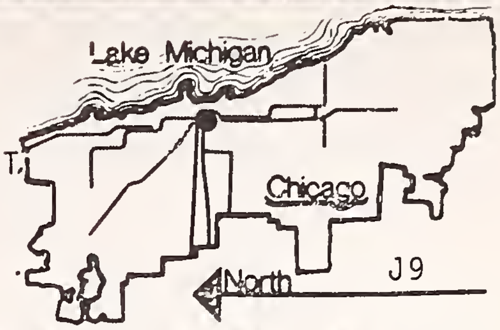
IN-CAR NOISE MEASUREMENT

ROUTE: MILWAUKEE SERVICE

SEGMENT:

FRANKLIN ST.- WELLS & VAN BUREN ST.

2 CAR 6000 SERIES



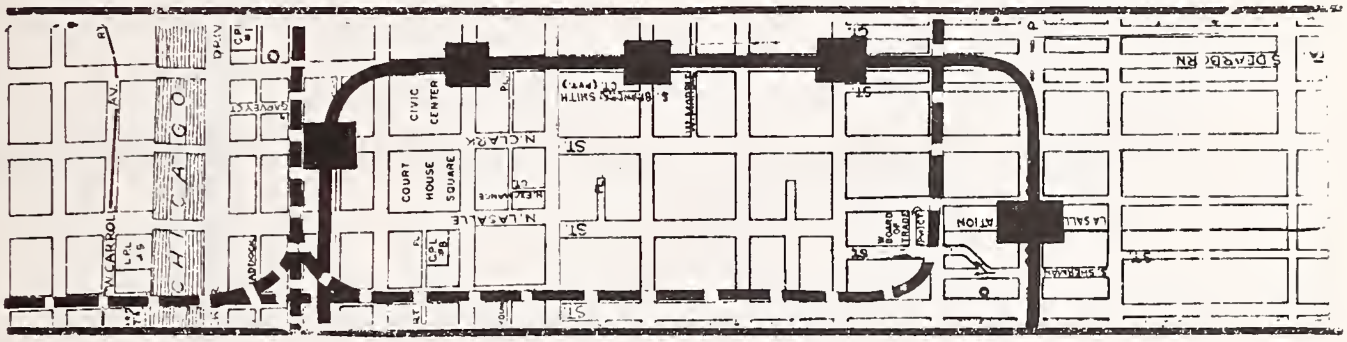
Structure

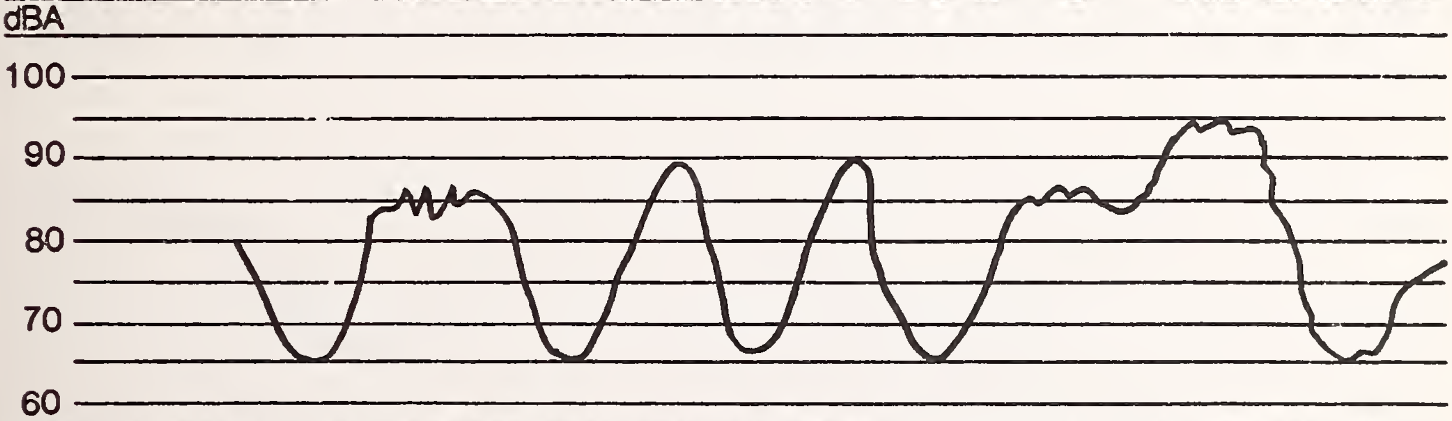
Geometry

Track

Station

LAKE TRANSFER WASHINGTON MONROE JACKSON LA SALLE





Speed (MPH) 0 25 0 25 0 25 0 25 0

Sources

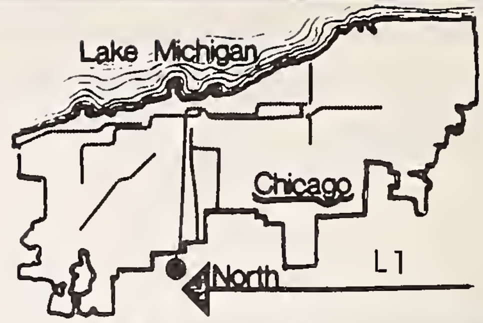
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: LAKE SERVICE

SEGMENT: HARLEM STATION - CLINTON AVE.

2 CAR 2200 SERIES



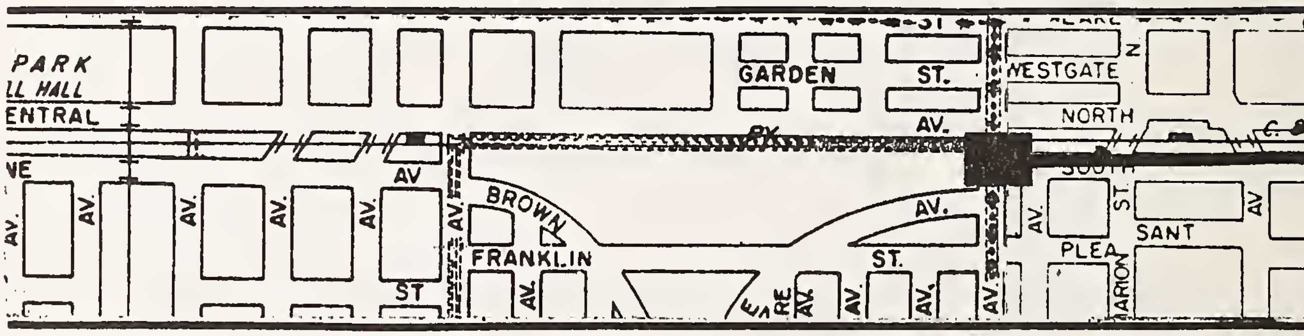
Structure

Geometry

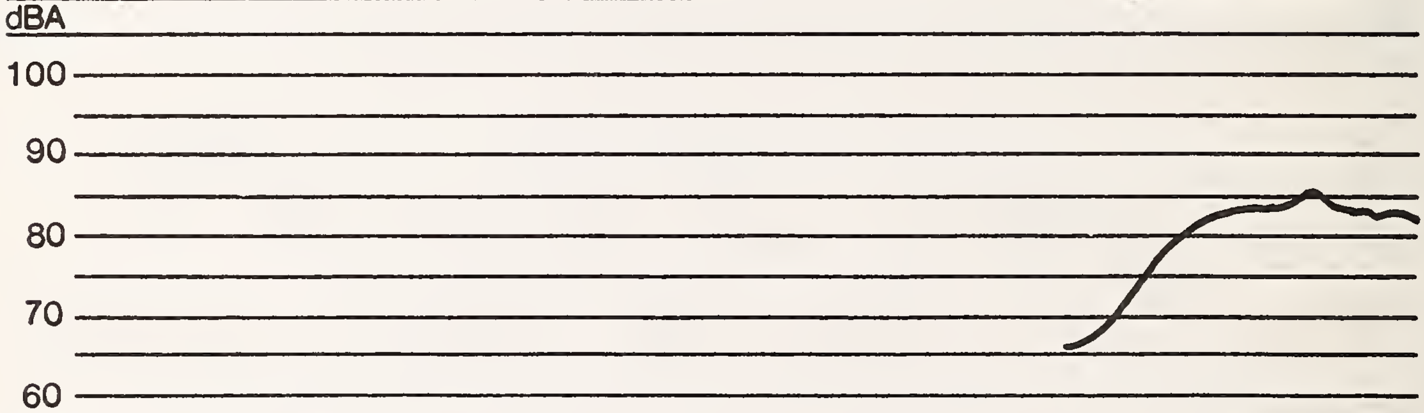
Track

Station

HARLEM (AB)



dBA



Speed (MPH) 0 30

Sources

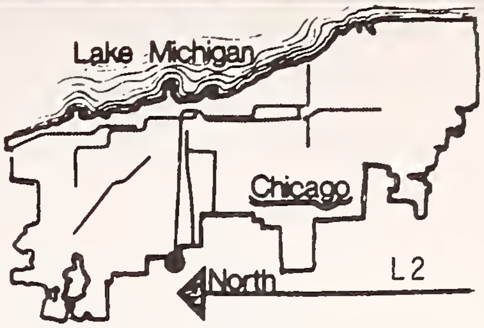
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: LAKE SERVICE

SEGMENT: CLINTON AVE. - AUSTIN STATION

2 CAR 2200 SERIES



Structure

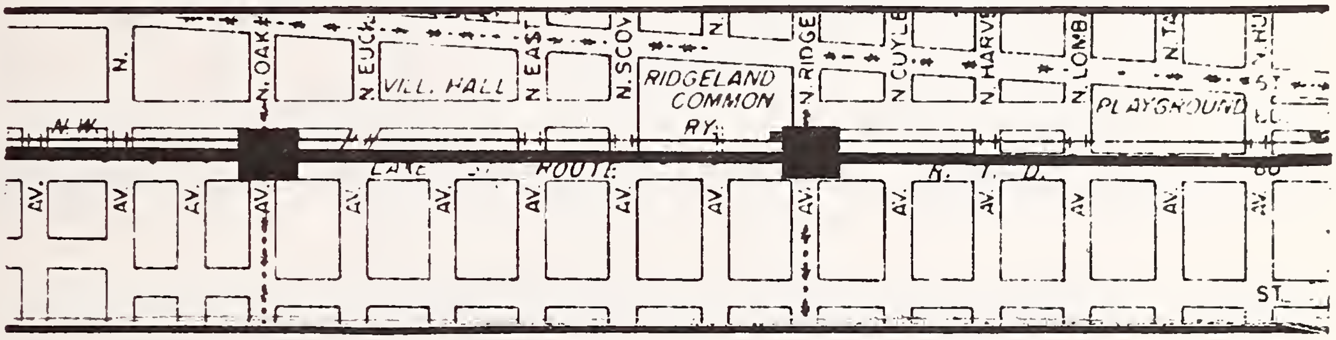
Geometry

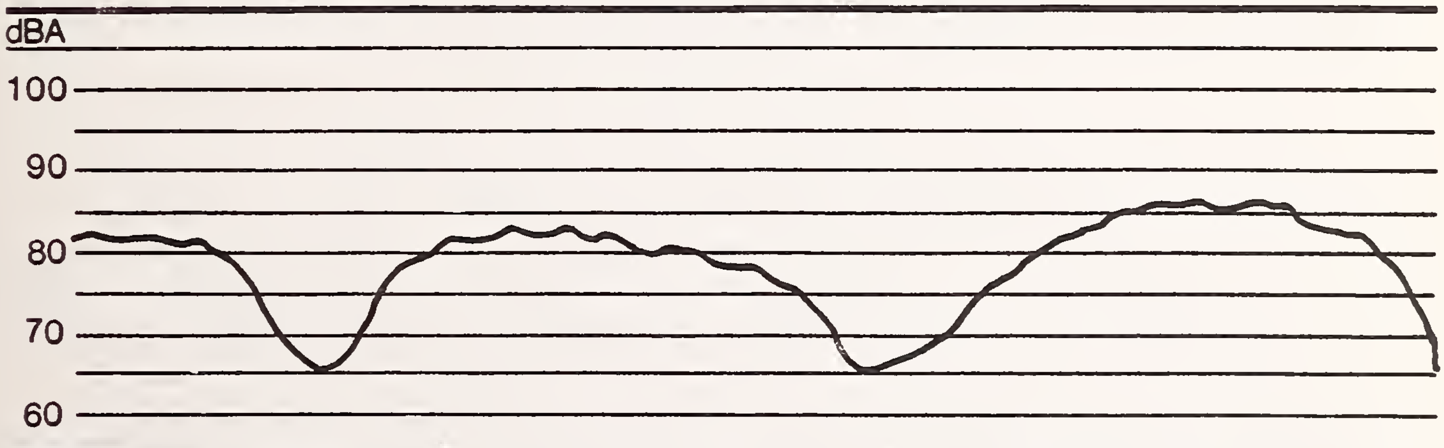
Track

Station

OAK PARK (AB)

RIDGELAND (AB)





Speed (MPH) 30 0 30 0 40 37

Sources

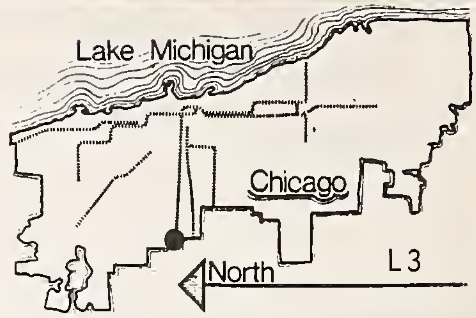
Paths

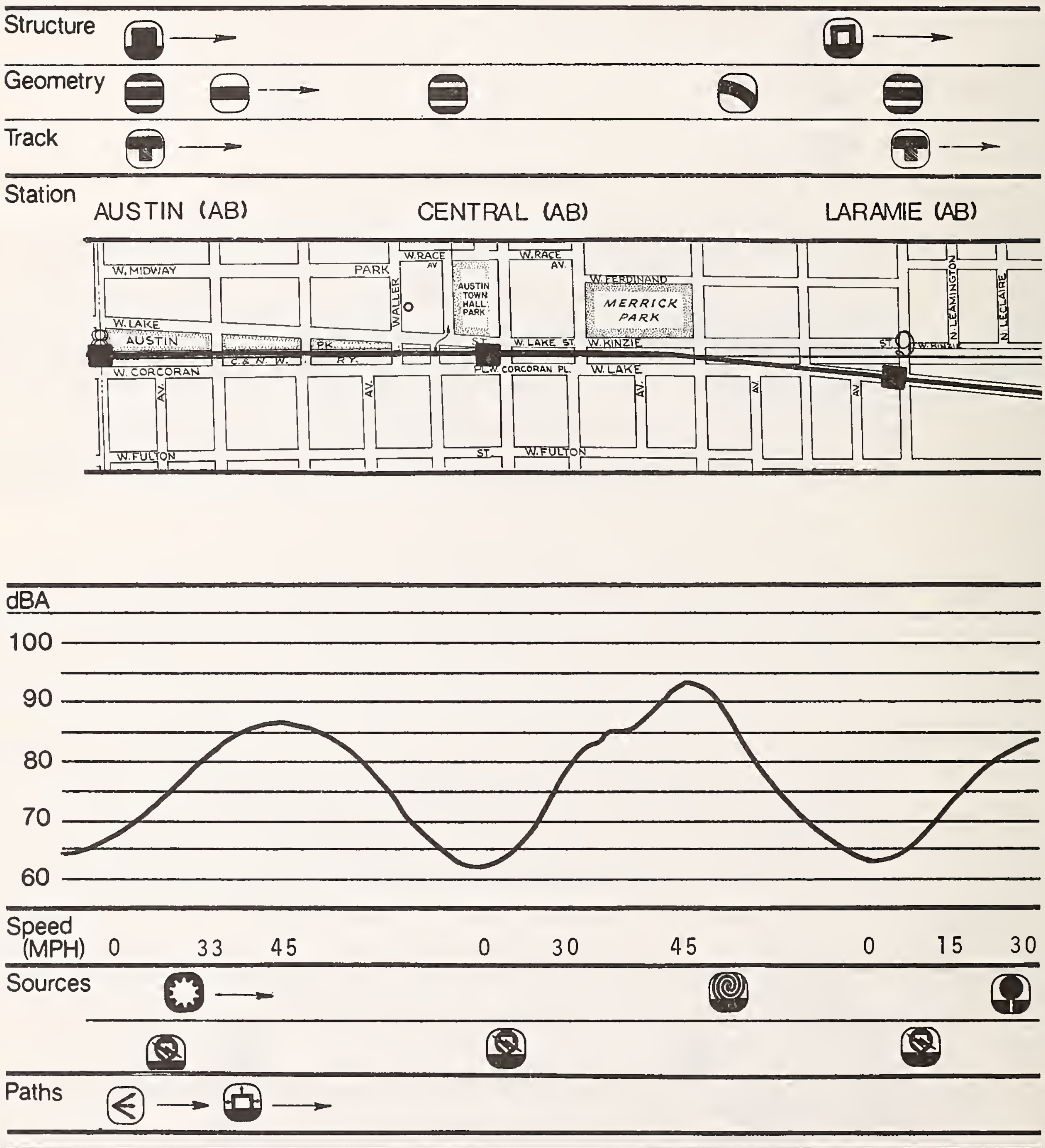
IN-CAR NOISE MEASUREMENT

ROUTE: LAKE SERVICE

SEGMENT: AUSTIN BLVD. - LAWYER AVE.

2 CAR 2200 SERIES



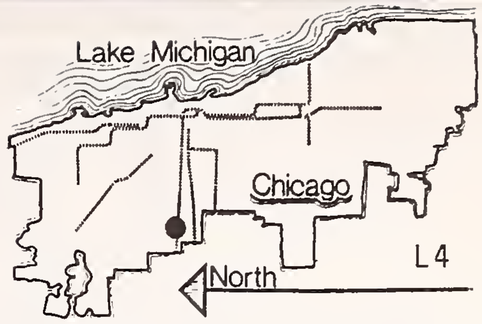


IN-CAR NOISE MEASUREMENT

ROUTE: LAKE SERVICE

SEGMENT: LAWLER AVE. - KARLOV AVE.

2 CAR 2200 SERIES



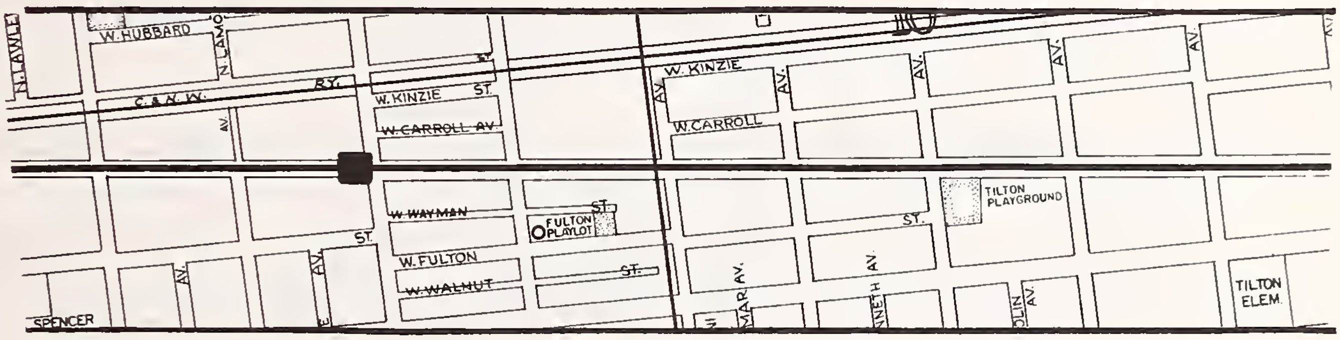
Structure

Geometry

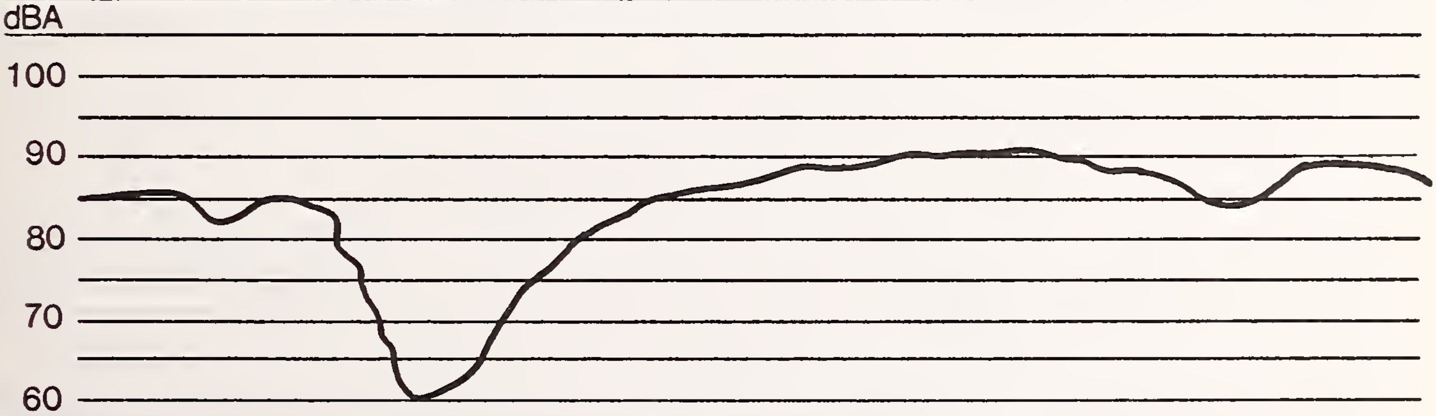
Track

Station

CICERO (AB)



dBA



Speed (MPH)	30	0	36	42	38	30	38

Sources

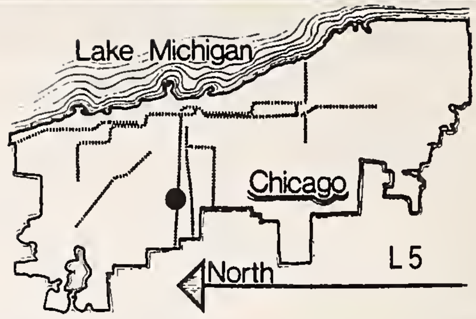
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **LAKE SERVICE**

SEGMENT: KARLOV AVE. - ALBANY AVE.

2 CAR 2200 SERIES



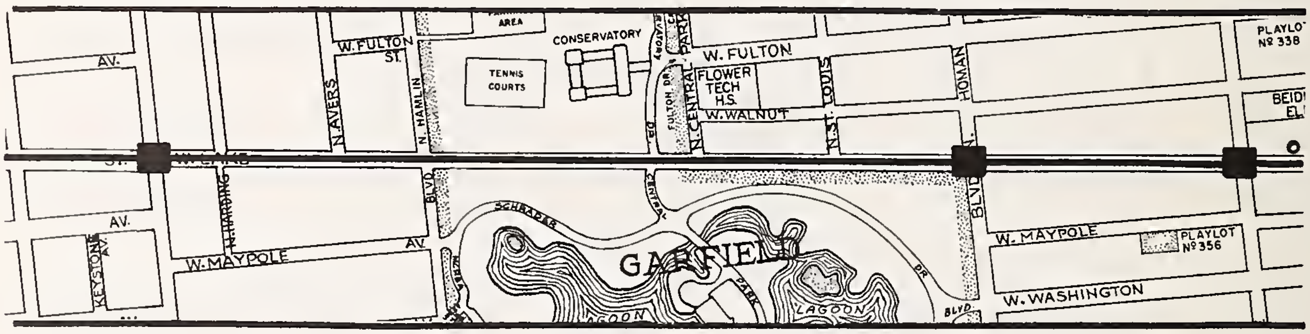
Structure →

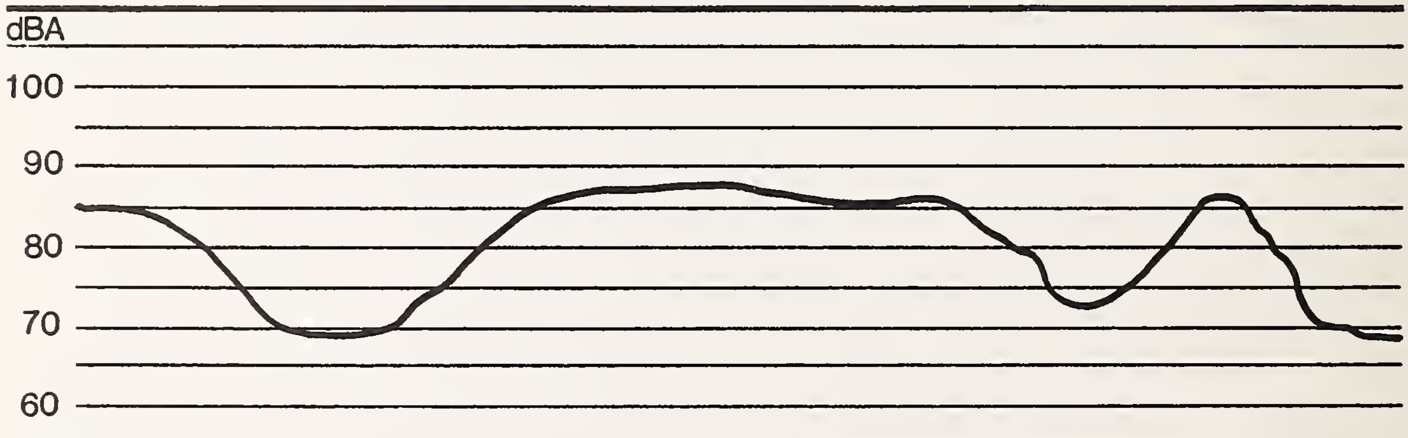
Geometry →

Track →

Station

PULASKI (AB) HOMAN (B)





Speed (MPH) 30 0 35 25 0

Sources → →

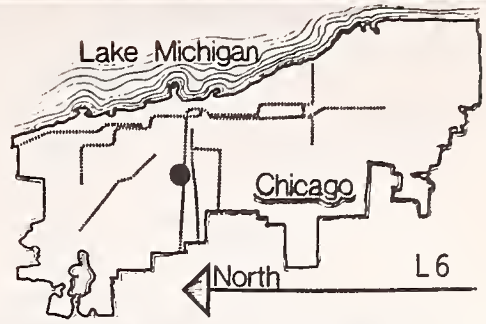
Paths → →

IN-CAR NOISE MEASUREMENT

ROUTE: **LAKE SERVICE**

SEGMENT: ALBANY AVE. - OAKLEY BLVD.

2 CAR 2200 SERIES



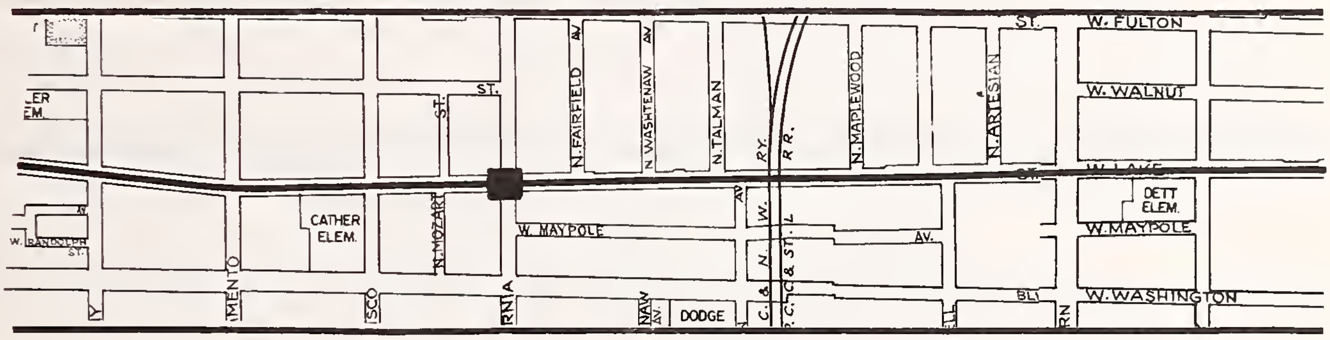
Structure

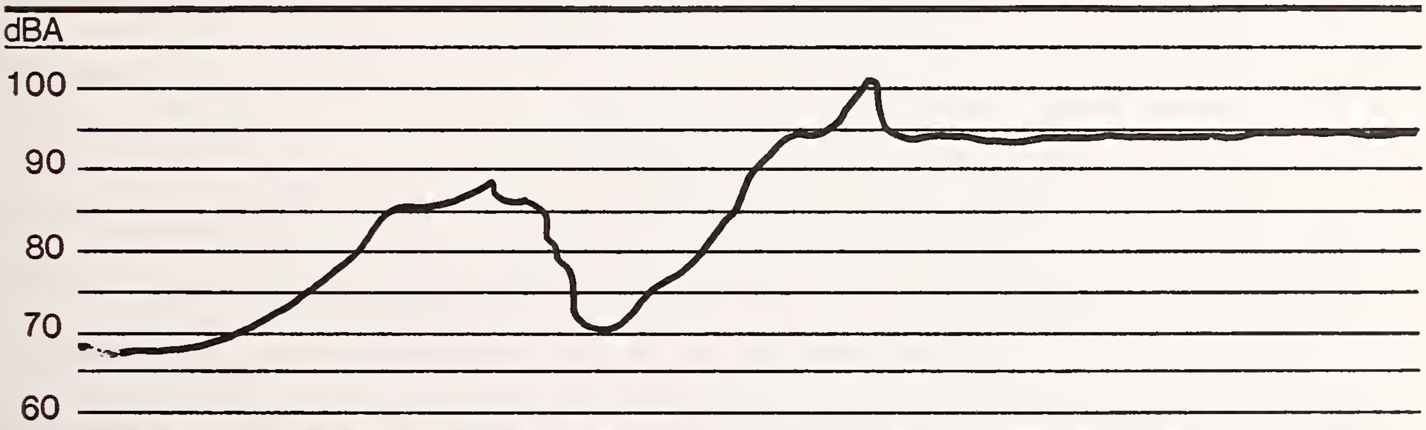
Geometry

Track

Station

CALIFORNIA (B)





Speed (MPH) 10 30 28 38 43 43

Sources

Paths

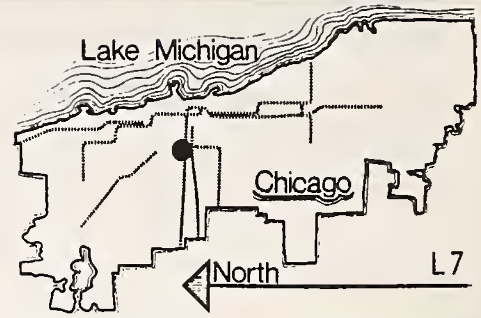
IN-CAR NOISE MEASUREMENT

ROUTE: **LAKE SERVICE**

SEGMENT:

OAKLEY BLVD. - ELIZABETH AVE.

2 CAR 2200 SERIES



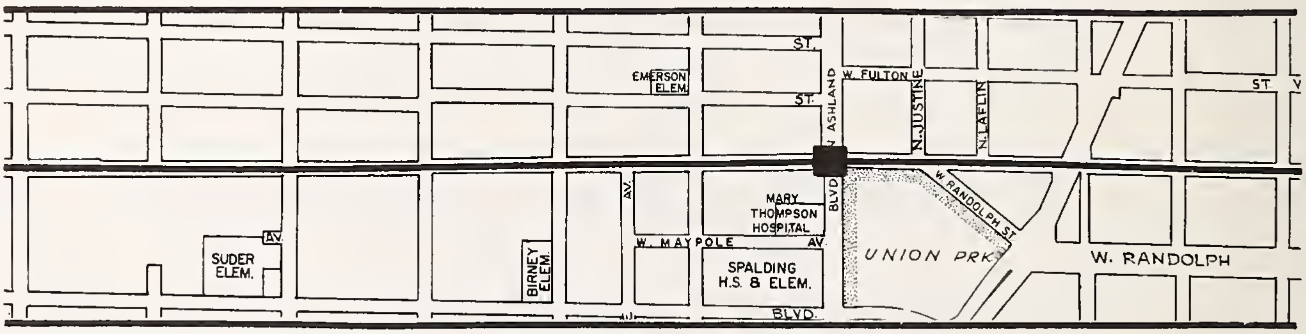
Structure

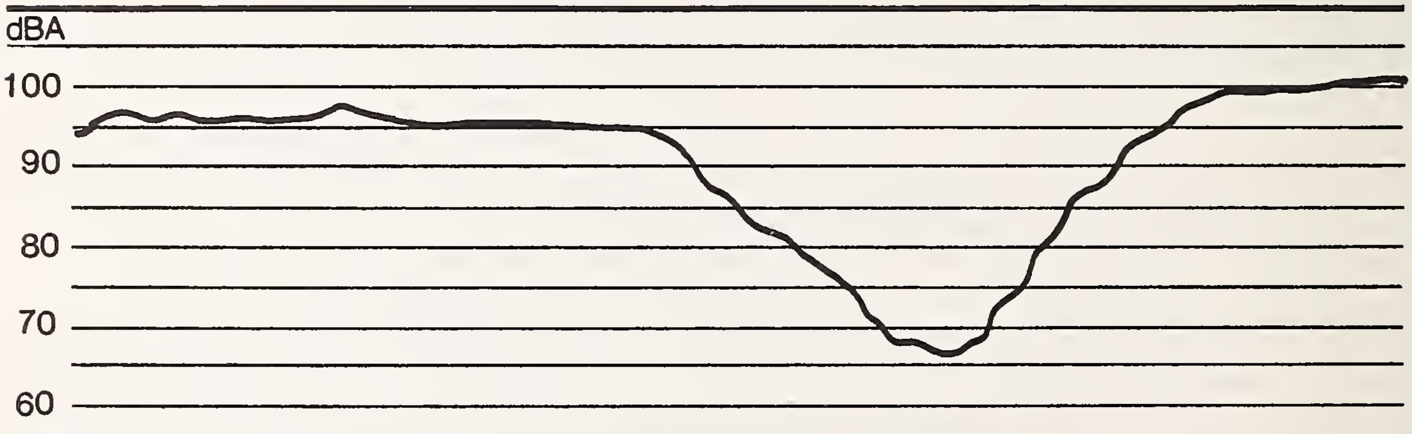
Geometry

Track

Station

ASHLAND (A)





Speed (MPH) 43 26 0 36 48

Sources

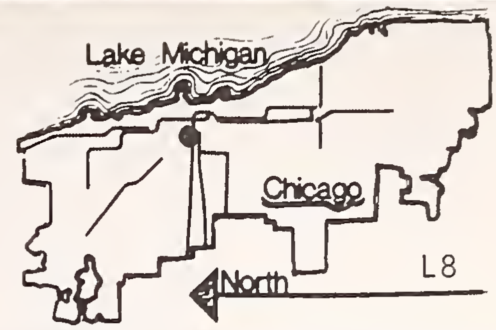
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: LAKE SERVICE

SEGMENT: ELIZABETH AVE. - DEARBORN ST.

2 CAR 2200 SERIES



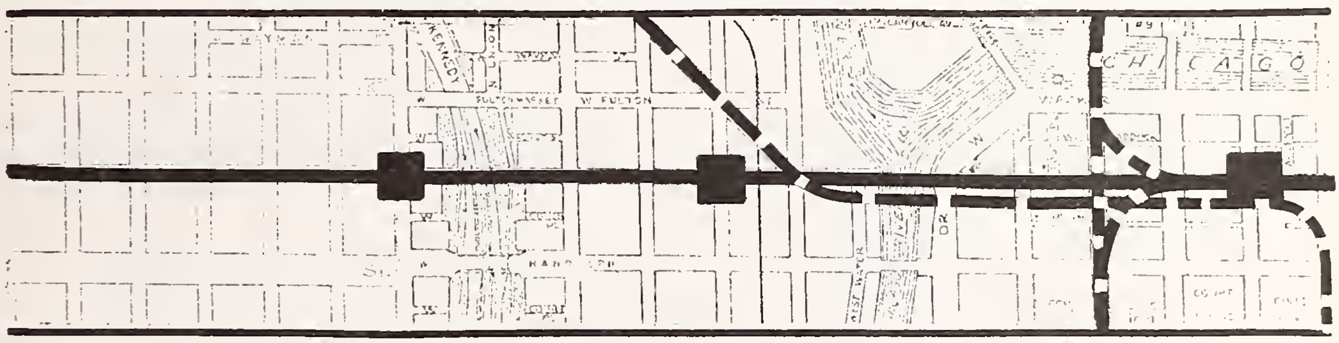
Structure

Geometry

Track

Station

HALSTED (B) CLINTON (AB) CLARK (AB)



dBA

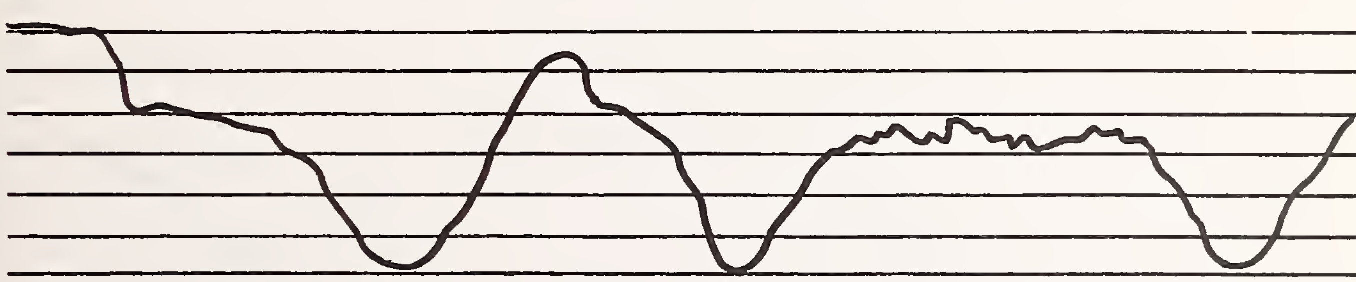
100

90

80

70

60



Speed (MPH)	48	26	0	40	0	18	0

Sources

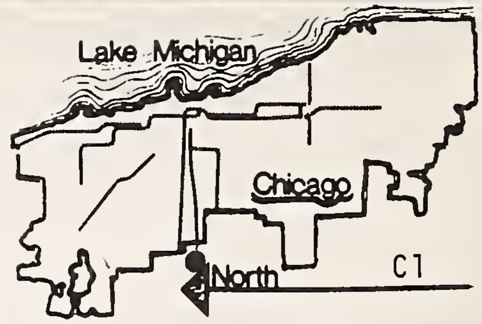
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: DES PLAINES STATION - CLINTON AVE.

2 CAR 6000 SERIES



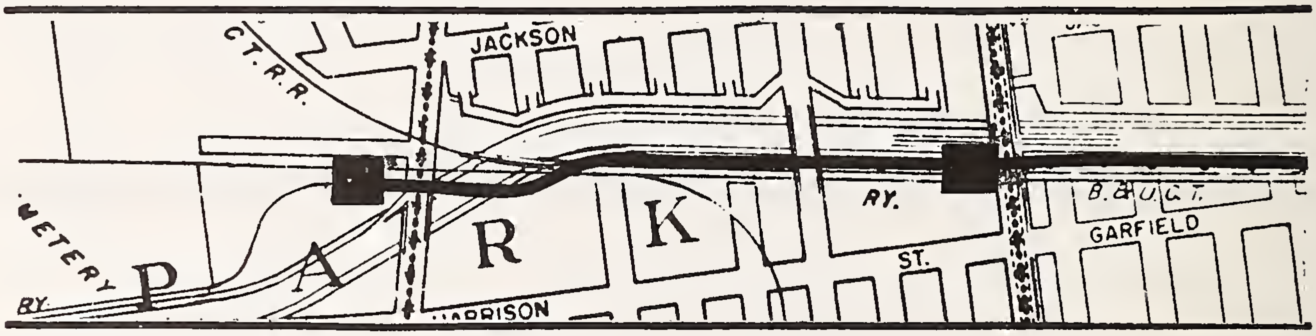
Structure

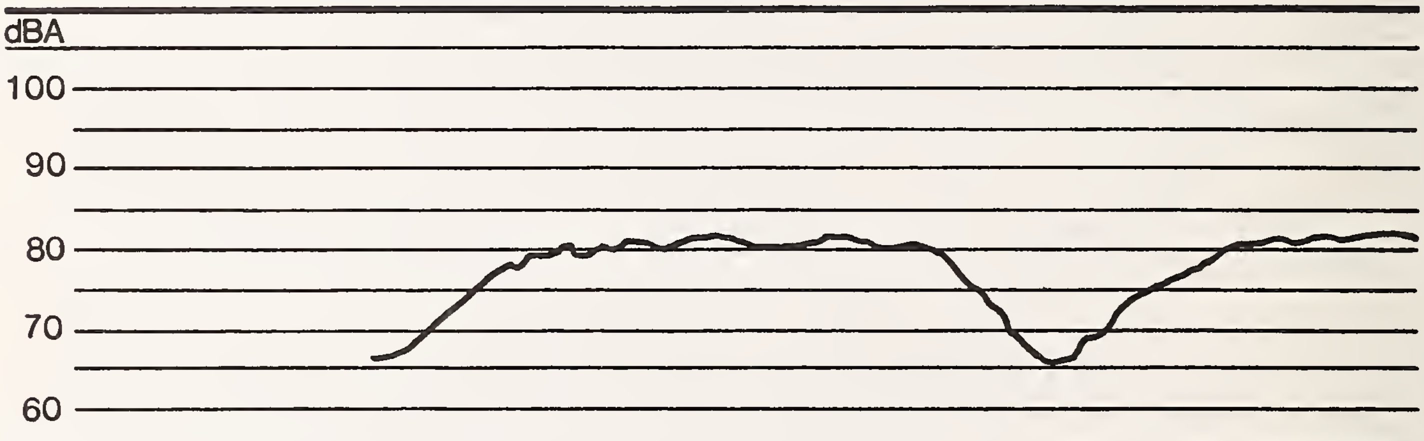
Geometry

Track

Station

DESPLAINES (A) HARLEM (A)





Speed (MPH)	0	35	0	44

Sources

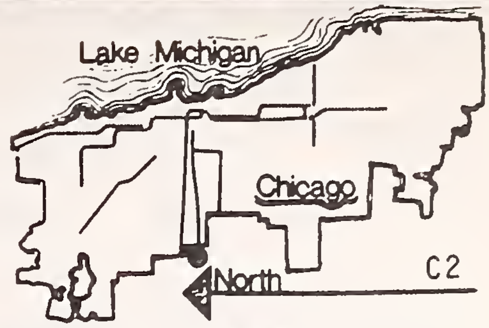
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: CLINTON AVE. - HUMPHREY AVE.

2 CAR 6000 SERIES



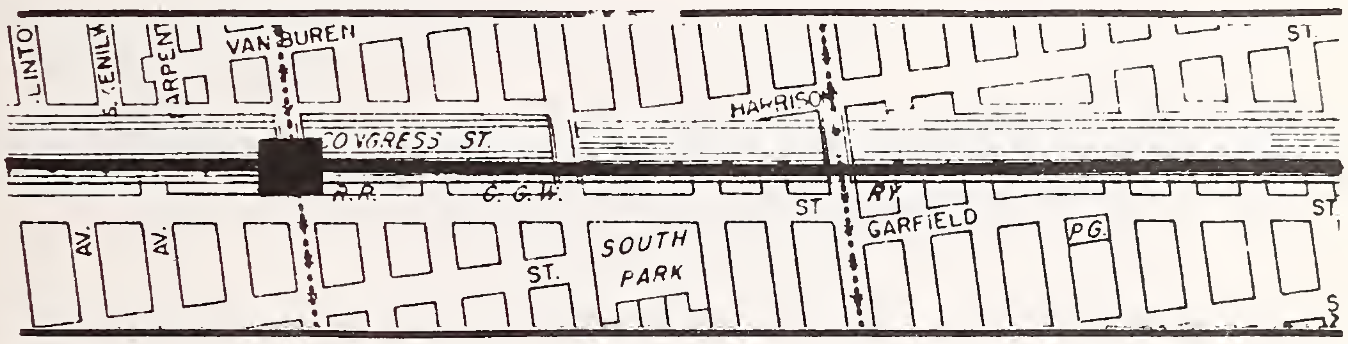
Structure

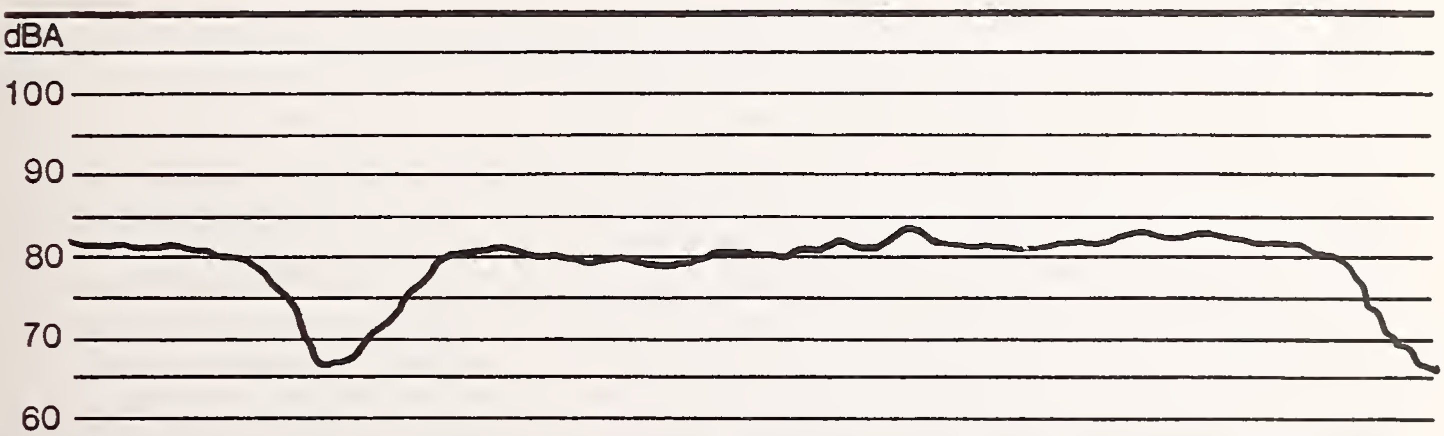
Geometry

Track

Station

OAK PARK (A)





Speed (MPH) 40 0 36 36

Sources

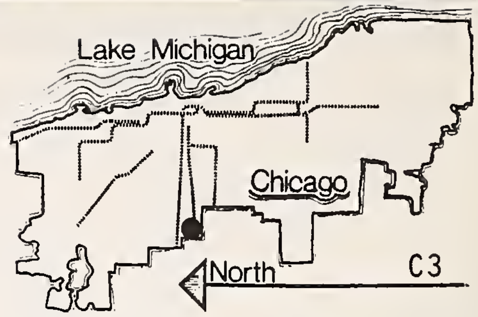
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: HUMPHREY AVE. - LEAMING AVE.

2 CAR 6000 SERIES



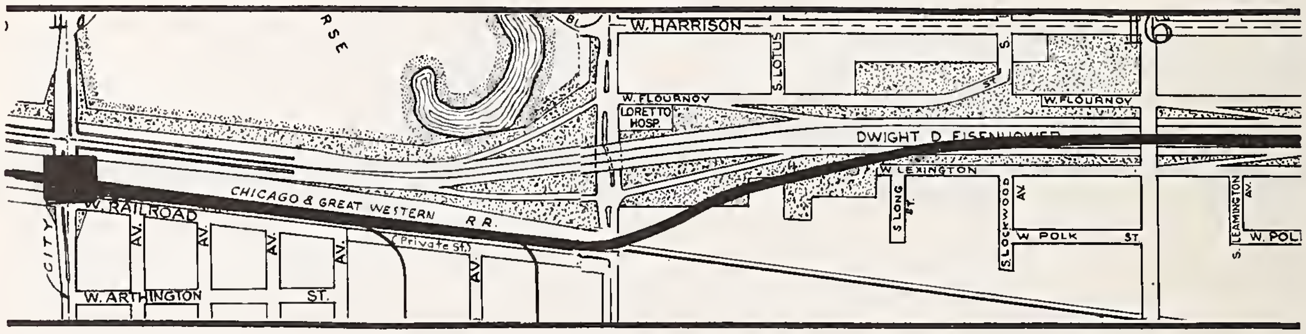
Structure

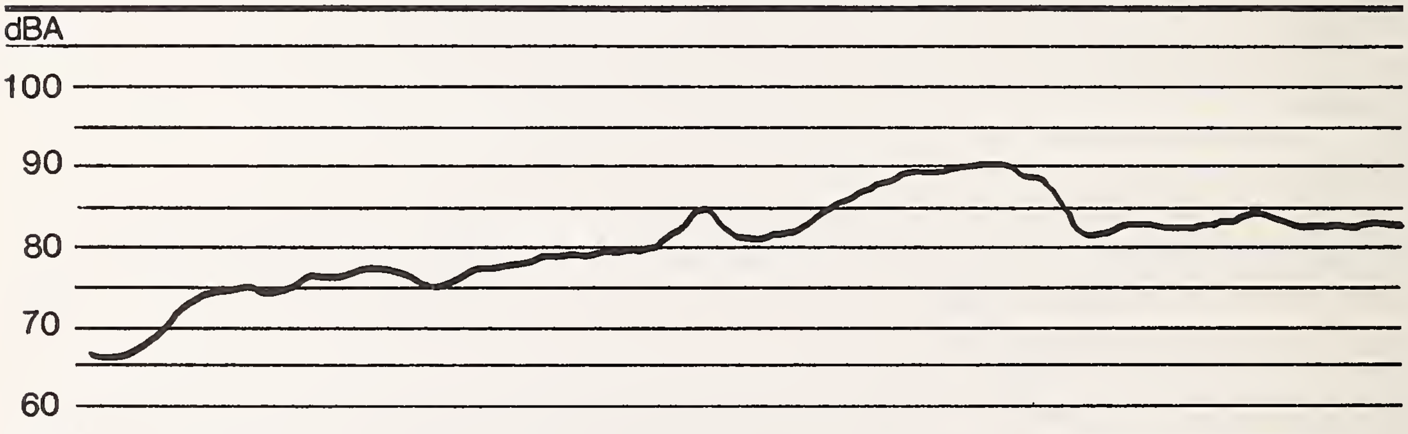
Geometry

Track

Station

AUSTIN (A)





Speed (MPH) 0 22 39 50 50

Sources

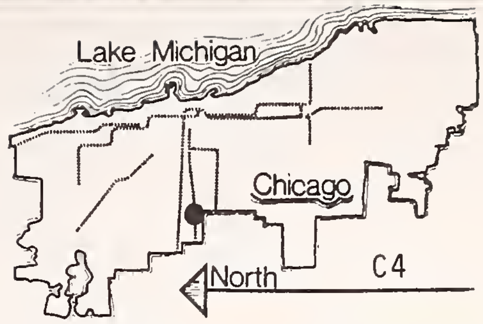
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: LEAMING AVE. - KARLOV ST.

2 CAR 6000 SERIES



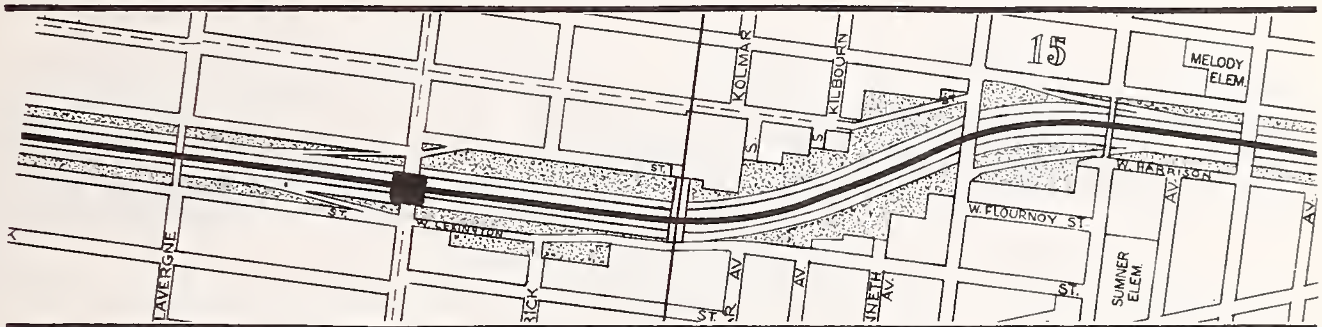
Structure

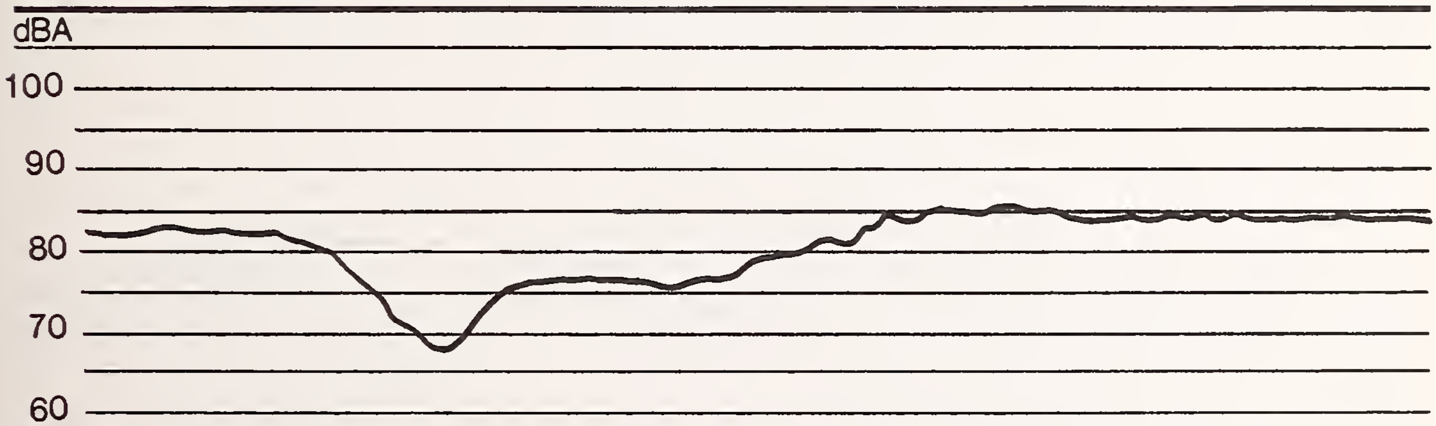
Geometry

Track

Station

CICERO (A)





Speed (MPH) 50 0 32 38 46

Sources

Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: KARLOV - KEDZIE STATION

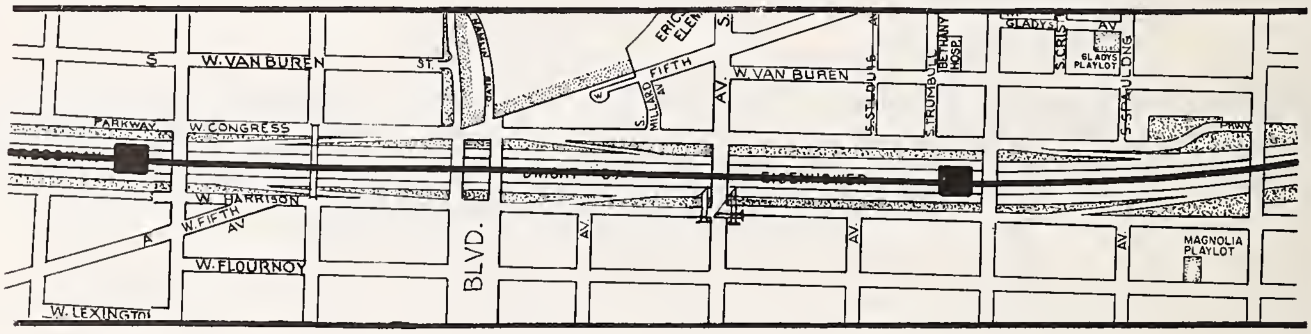
2 CAR 6000 SERIES

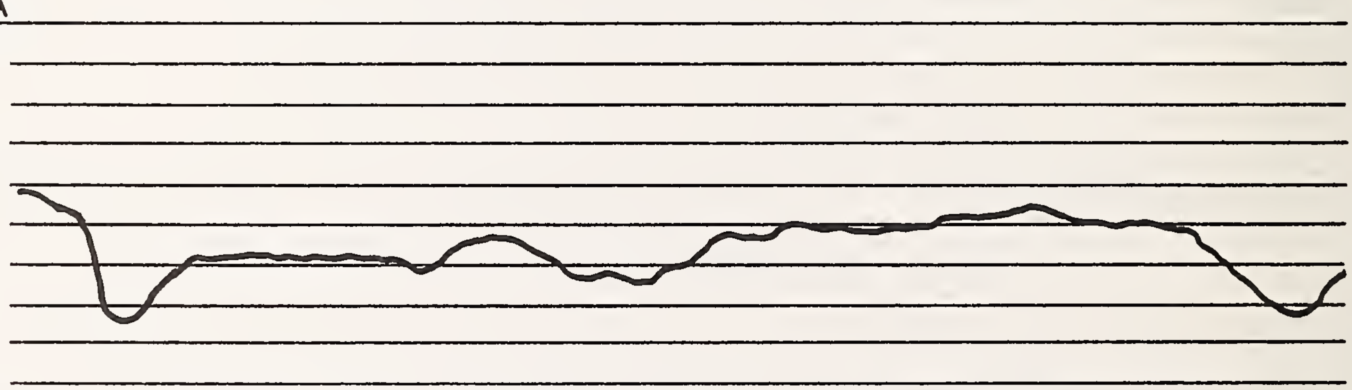
Structure

Geometry

Track

Station PULASKI (A) KEDZIE (A)





Speed (MPH) 0 26 37 26 32 0

Sources

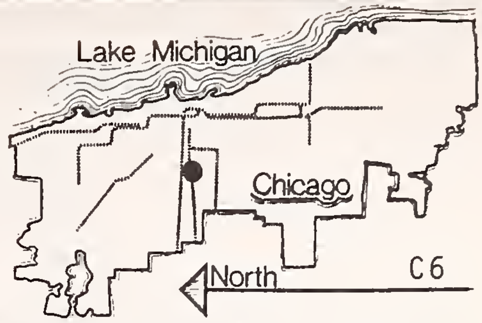
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: KEDZIE AVE. - LEAVITT AVE.

2 CAR 6000 SERIES



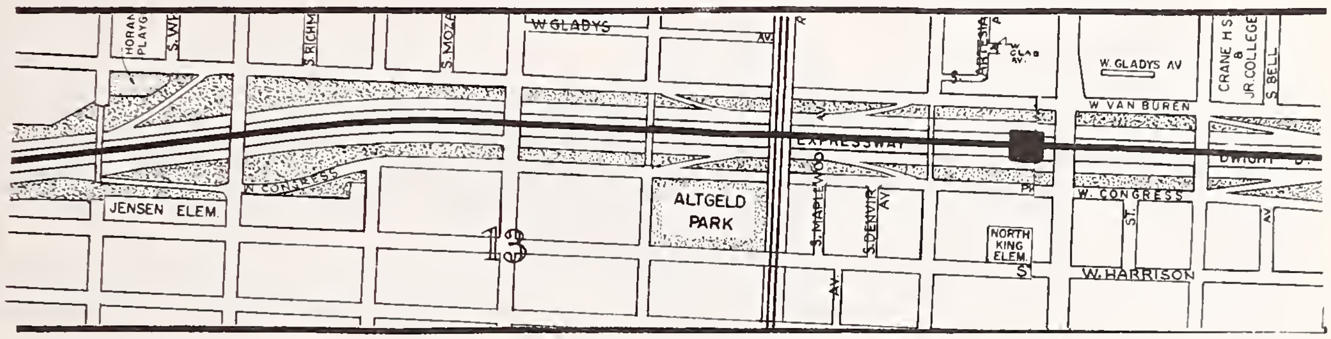
Structure

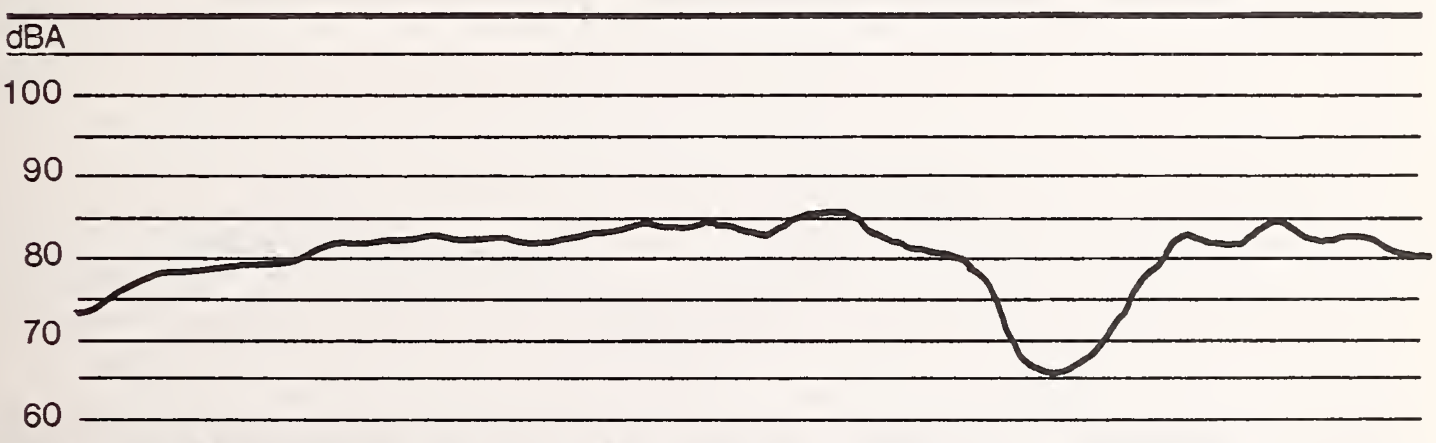
Geometry

Track

Station

WESTERN (A)





Speed (MPH)	32	40	48	0	33

Sources

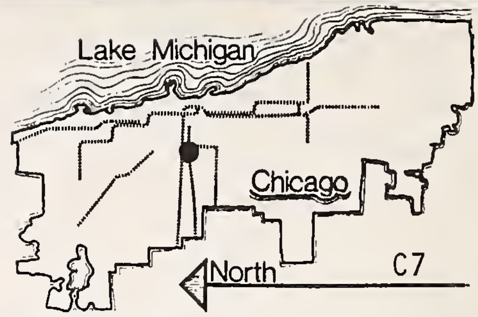
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: LEAVITT AVE. - RACINE AVE.

2 CAR 6000 SERIES



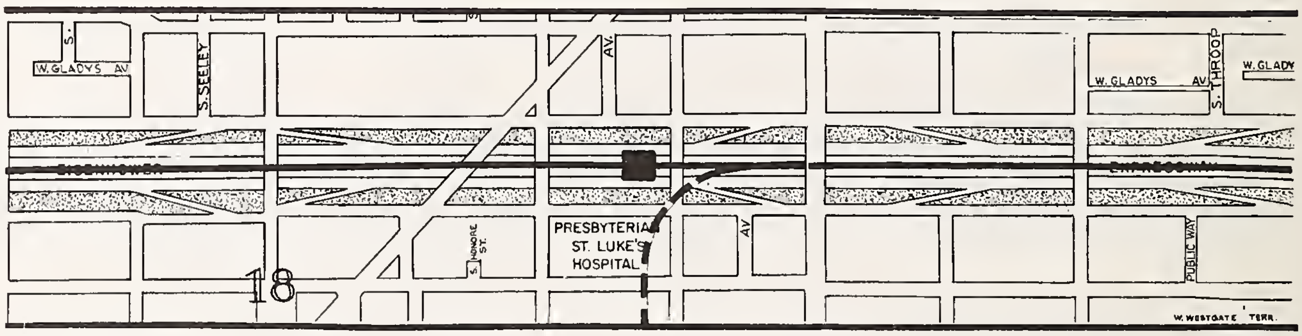
Structure

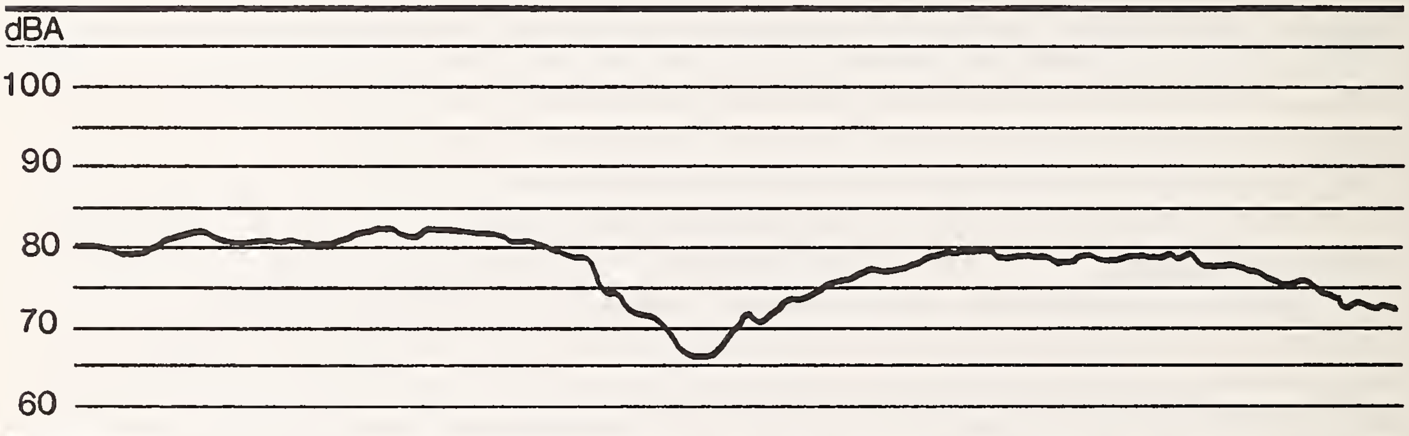
Geometry

Track

Station

MEDICAL CENTER (A)





Speed (MPH) 40 44 0 35

Sources

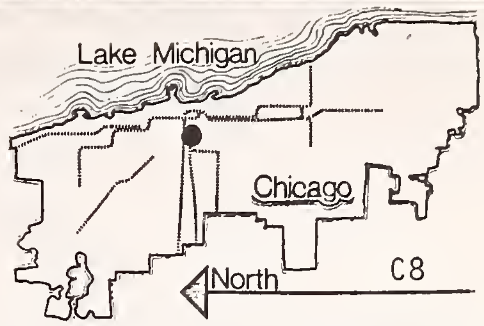
Paths

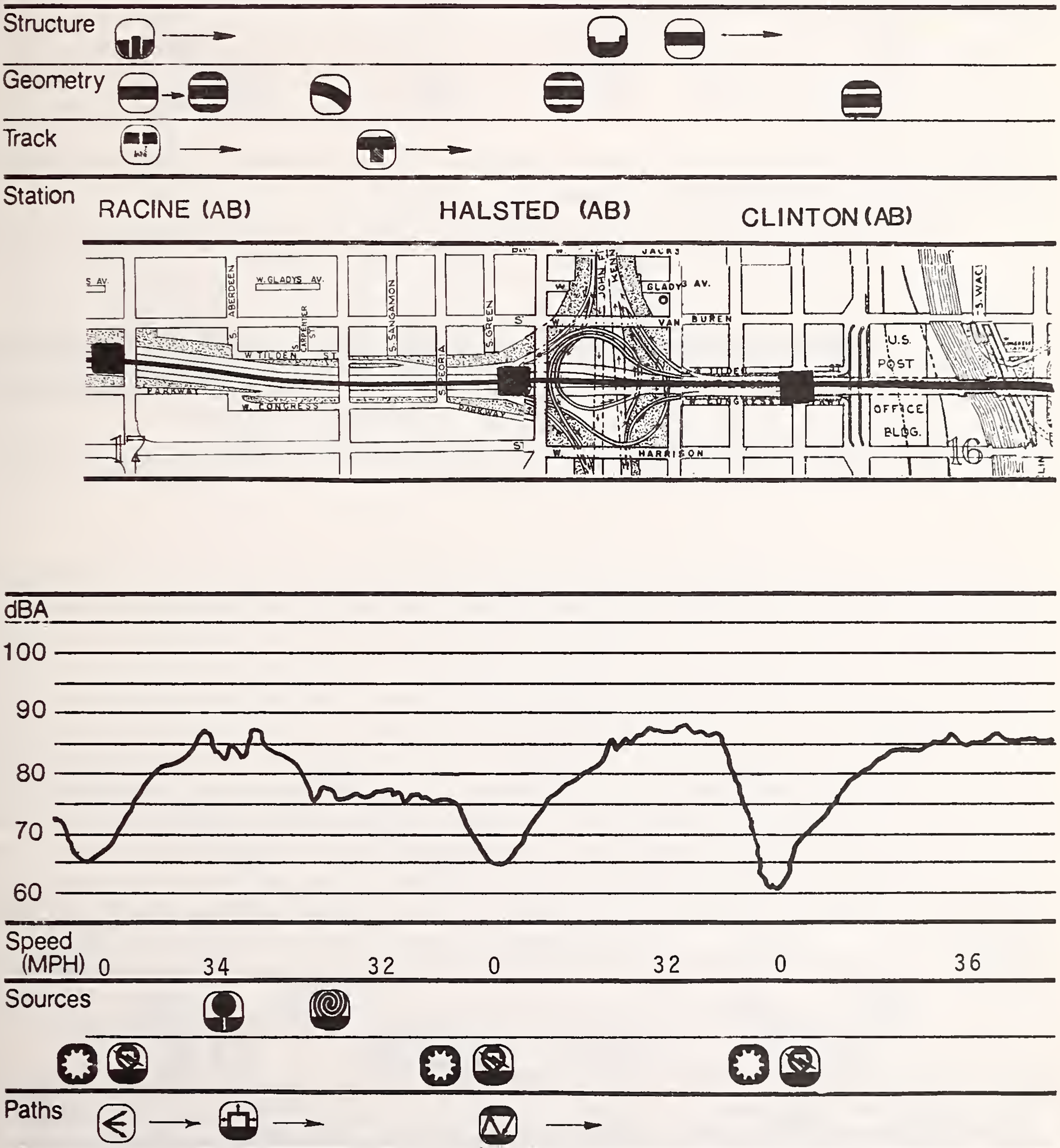
IN-CAR NOISE MEASUREMENT

ROUTE: CONGRESS SERVICE

SEGMENT: RACINE AVE. - WACKER DRIVE

2 CAR 6000 SERIES



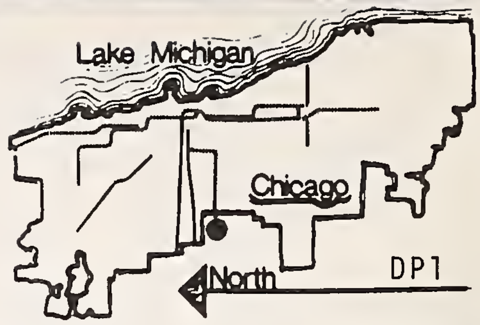


IN-CAR NOISE MEASUREMENT

ROUTE: DOUGLAS SERVICE

SEGMENT: 54th ST. - BELT RAILROAD

2 CAR 6000 SERIES



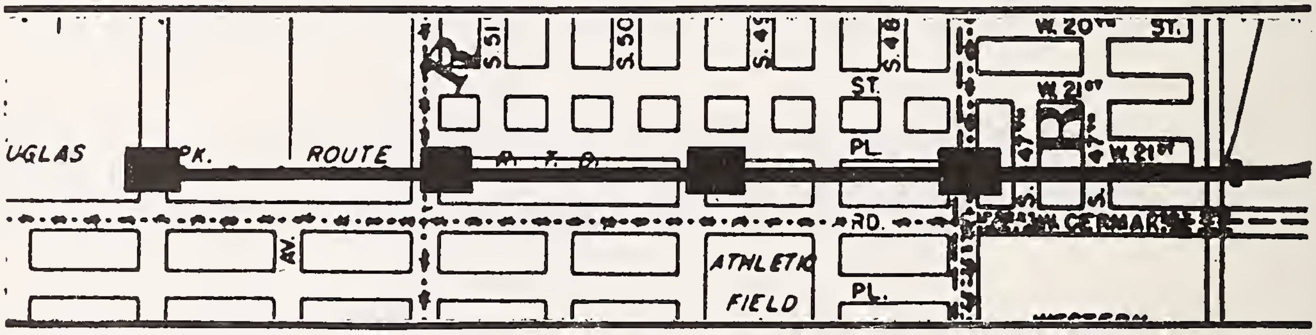
Structure

Geometry

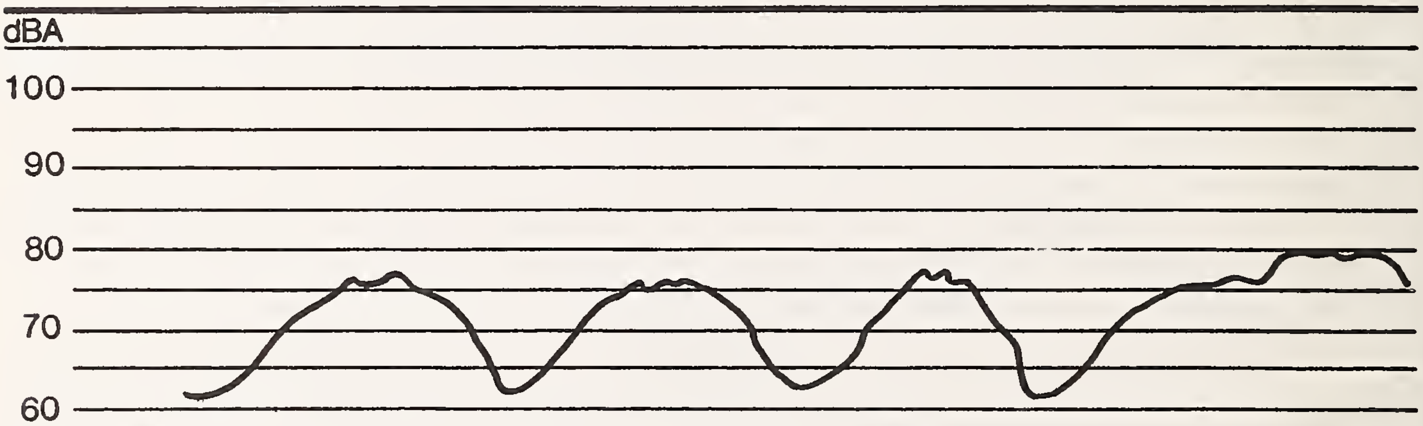
Track

Station

CICERO-BERWYN (B) LARAMIE (B) 50 TH (B) CICERO (B)



dBA



Speed (MPH) 0 23 0 24 0 24 0 25

Sources

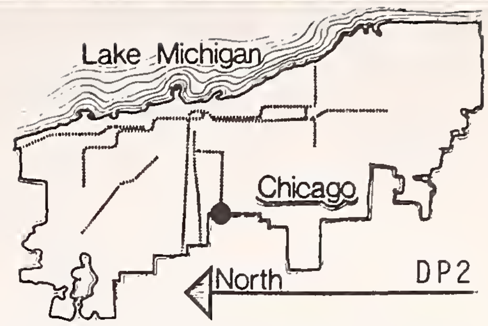
Paths

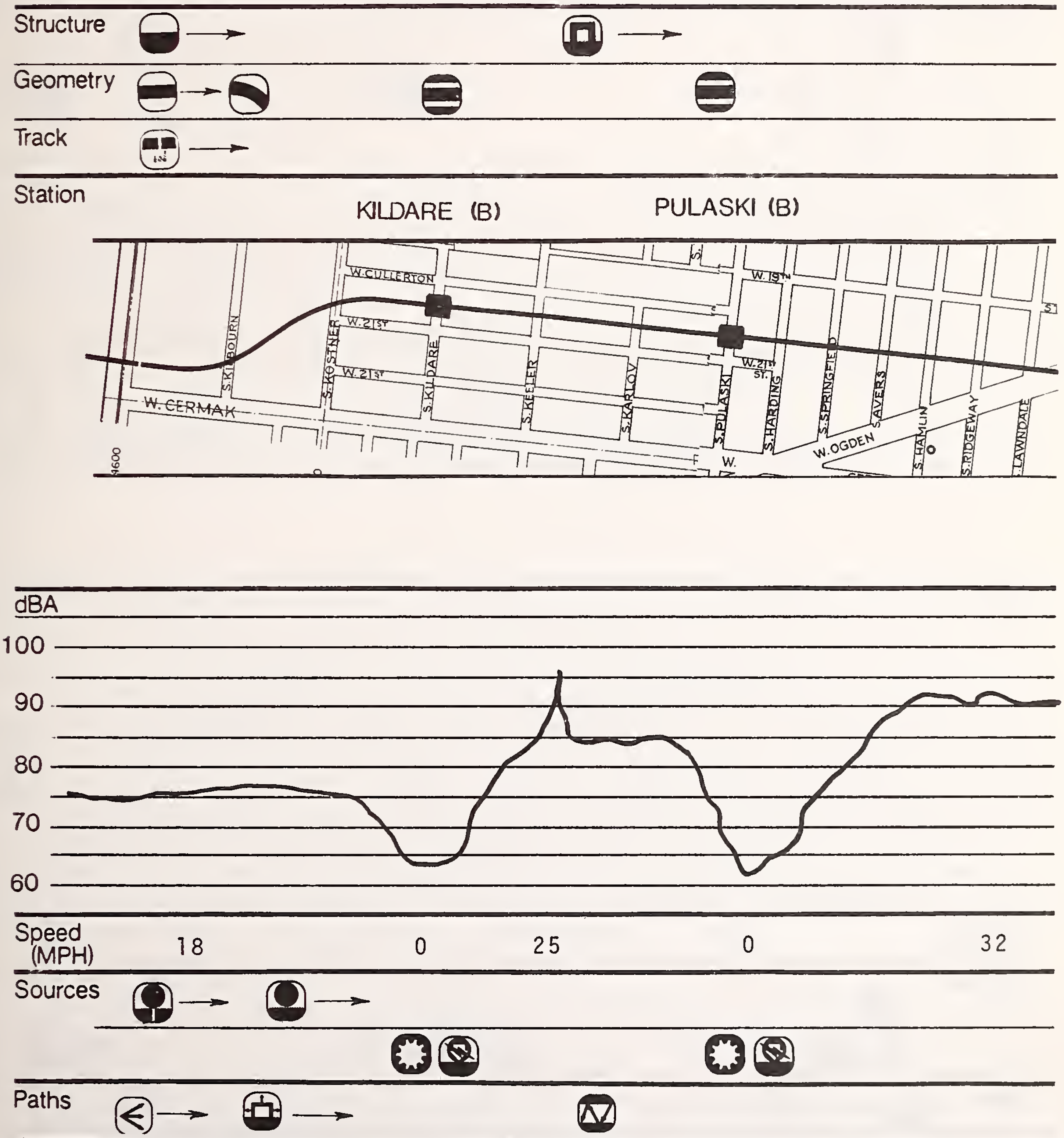
IN-CAR NOISE MEASUREMENT

ROUTE: DOUGLAS SERVICE

SEGMENT: BELT RAILROAD - LAWNDALE AVE.

2 CAR 6000 SERIES



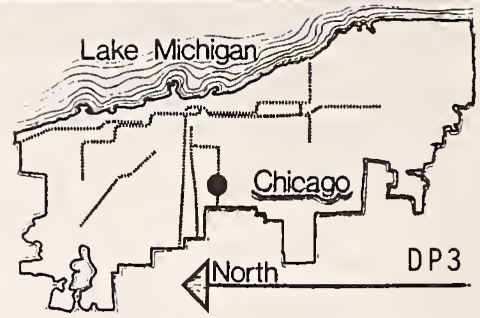


IN-CAR NOISE MEASUREMENT

ROUTE: DOUGLAS SERVICE

SEGMENT: LAWNDALE AVE. - WASHTENAW AVE.

2 CAR 6000 SERIES

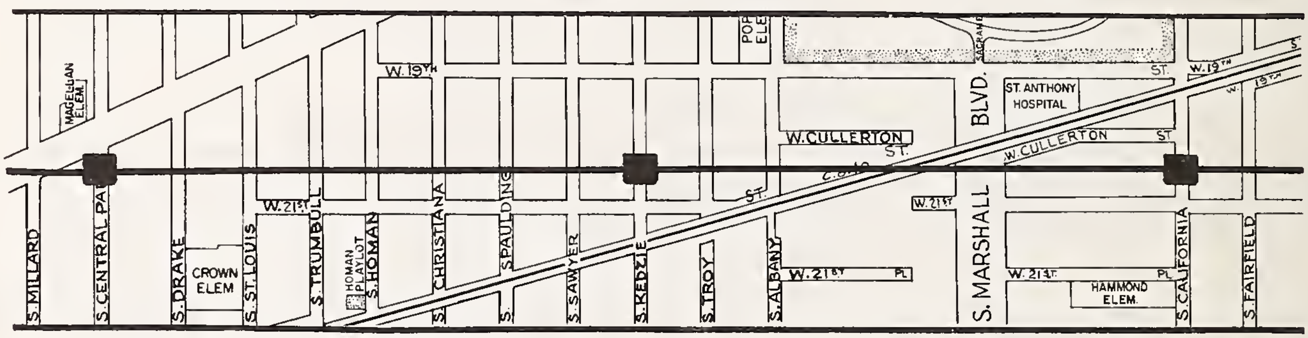


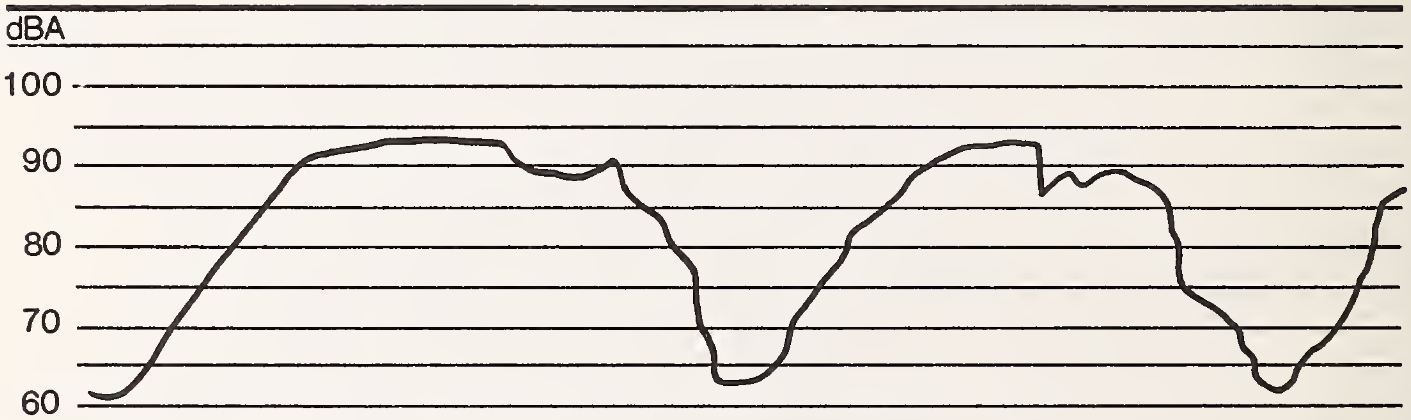
Structure

Geometry

Track

Station CENTRAL PARK (B) KEDZIE (B) CALIFORNIA (B)





Speed (MPH) 0 32 20 0 30 22 0

Sources

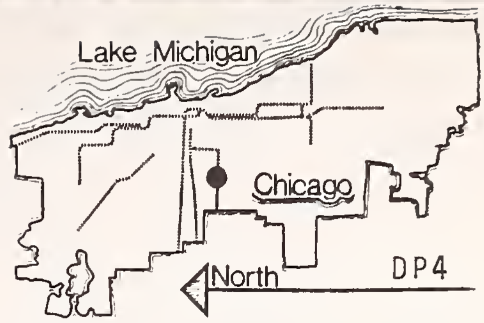
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DOUGLAS SERVICE

SEGMENT: WASHTENAW AVE. - TAYLOR ST.

2 CAR 6000 SERIES



DP4

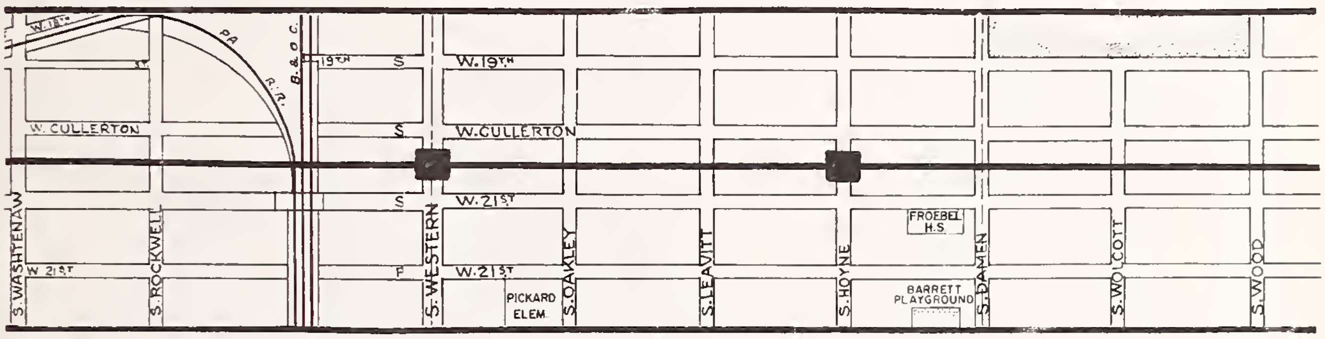
Structure

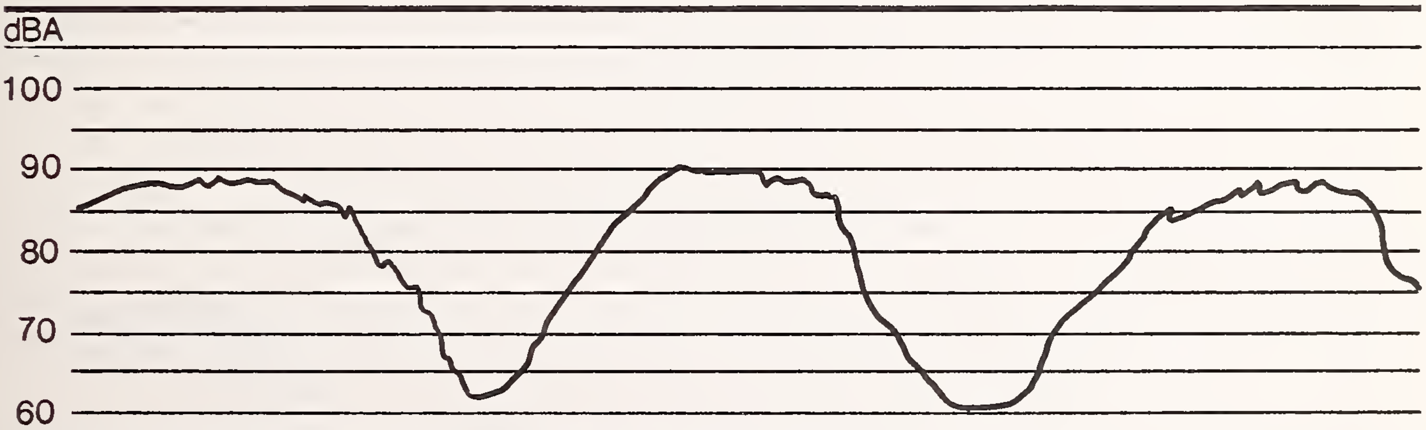
Geometry

Track

Station

WESTERN (B) HOYNE (B)





Speed (MPH)	40	0	25	0	32

Sources

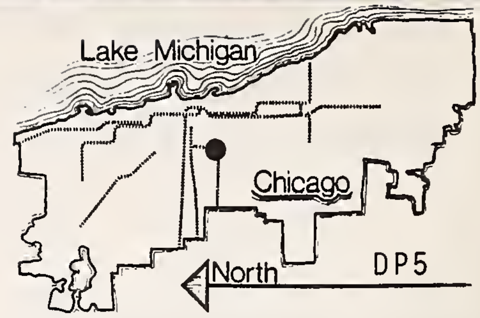
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **DOUGLAS SERVICE**

SEGMENT: 21st ST. - TAYLOR ST.

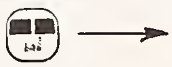
2 CAR 6000 SERIES



Structure

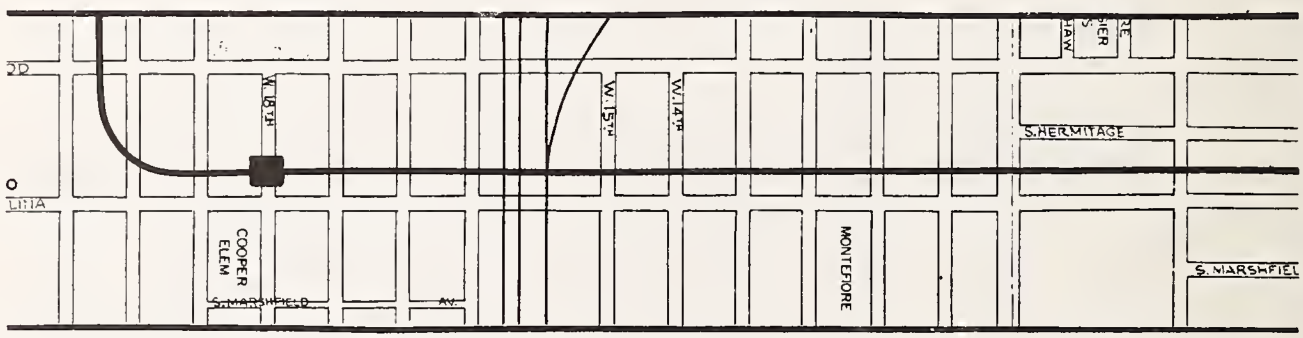
Geometry

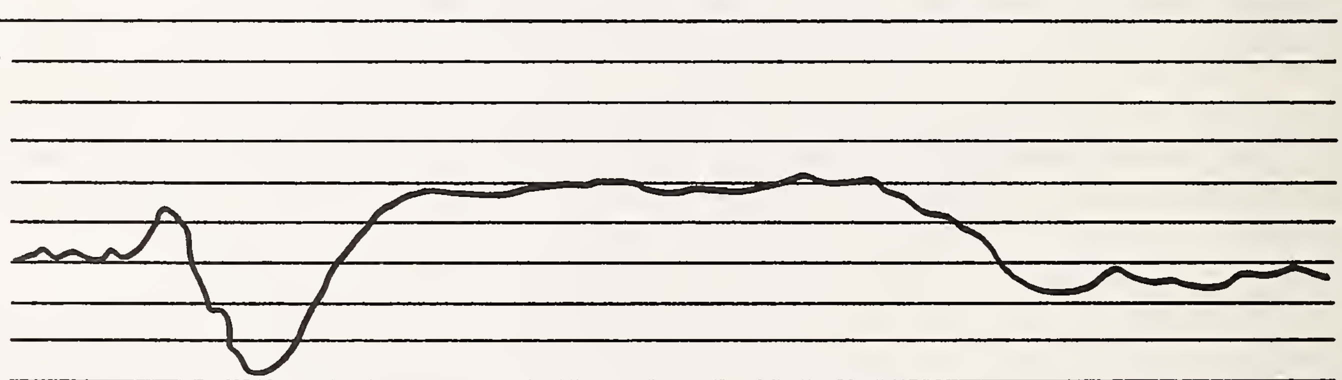
Track



Station

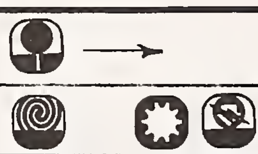
18 TH (B)





Speed (MPH) 10 0 35 13

Sources



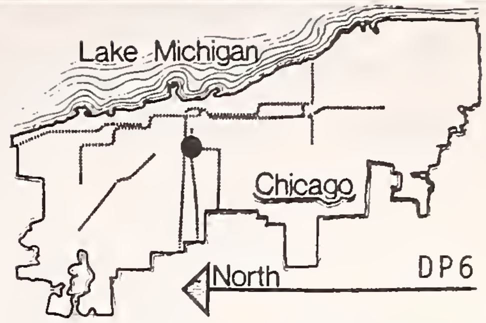
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DOUGLAS SERVICE

SEGMENT: TAYLOR ST. - ASHLAND BLVD.

2 CAR 6000 SERIES



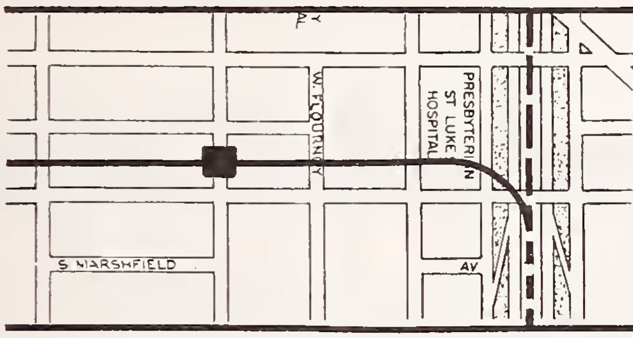
Structure

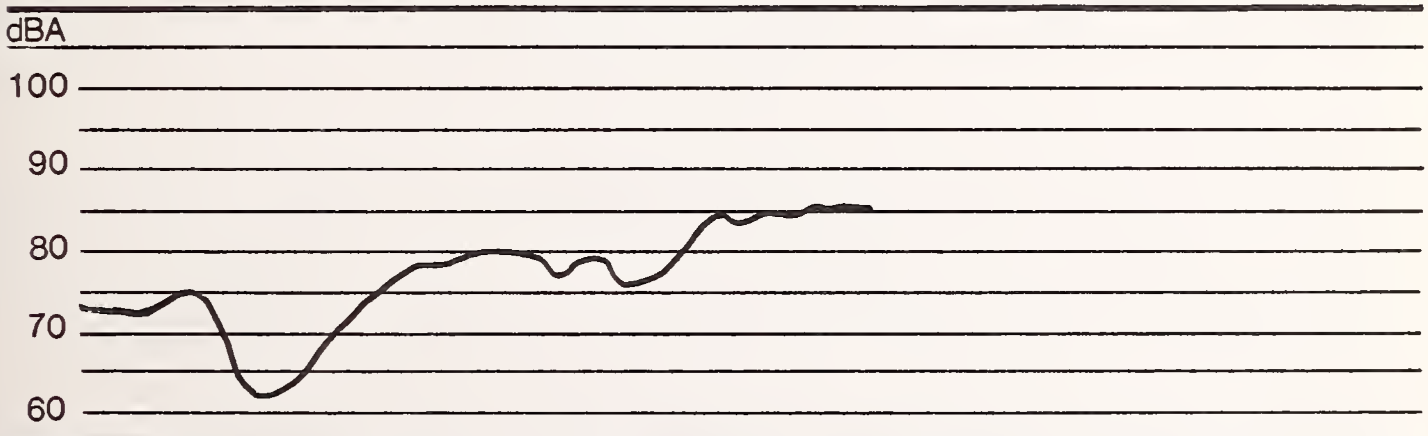
Geometry

Track

Station

POLK (B)





Speed (MPH) 13 0 20 15 30

Sources

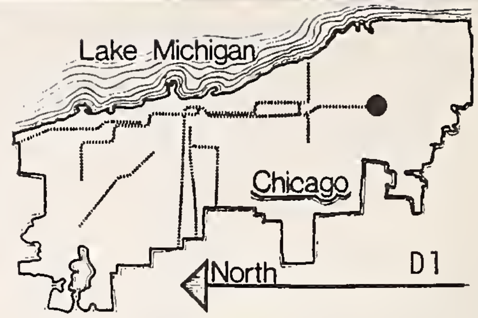
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: 95th ST. - 86th ST.

2 CAR 2200 SERIES

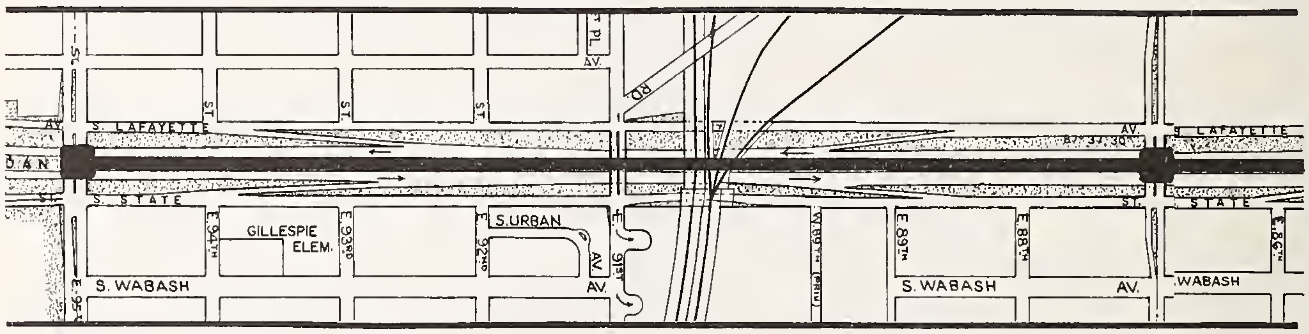


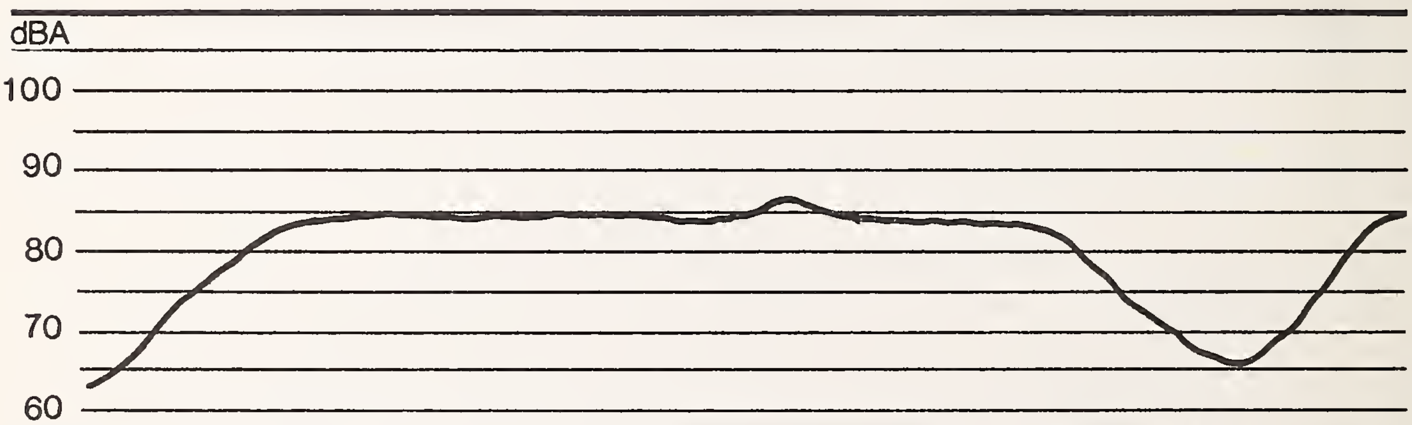
Structure

Geometry

Track

Station 95 TH (AB) 87 TH (AB)





Speed (MPH) 0 45 0 45

Sources

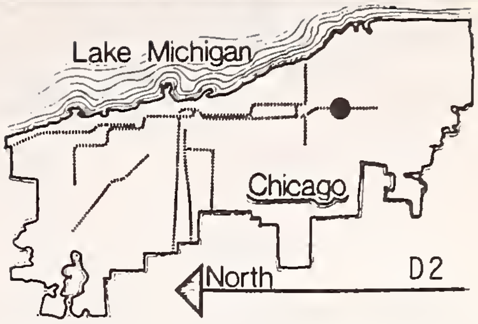
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: 86th ST. - 76th ST.

2 CAR 2200 SERIES



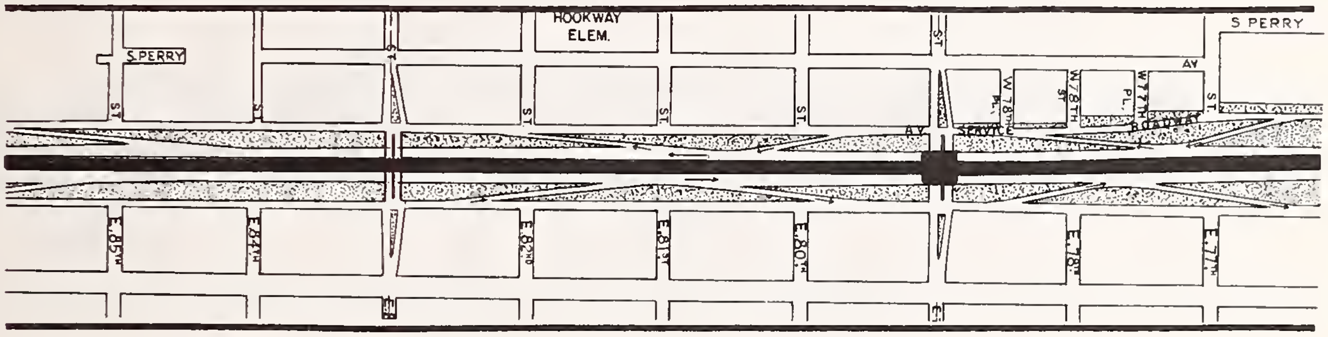
Structure

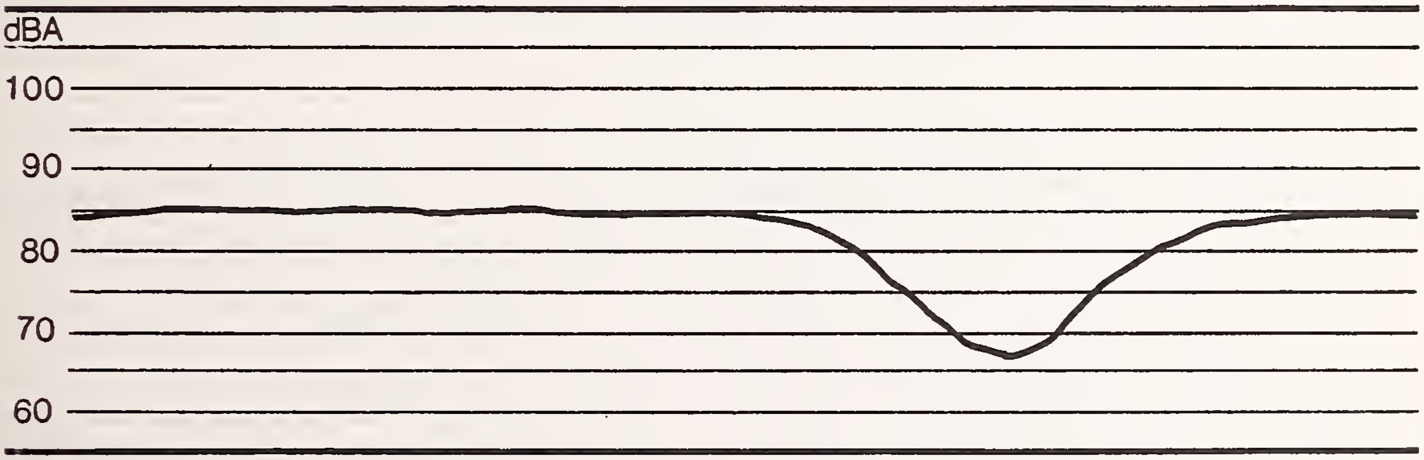
Geometry

Track

Station

79 TH (AB)





Speed (MPH) 45 0 46

Sources

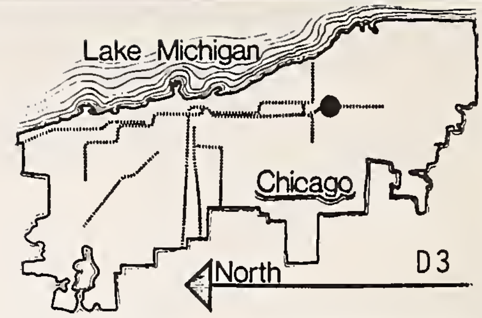
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **DAN RYAN SERVICE**

SEGMENT: 76th ST. - MARQUETTE ROAD

2 CAR 2200 SERIES



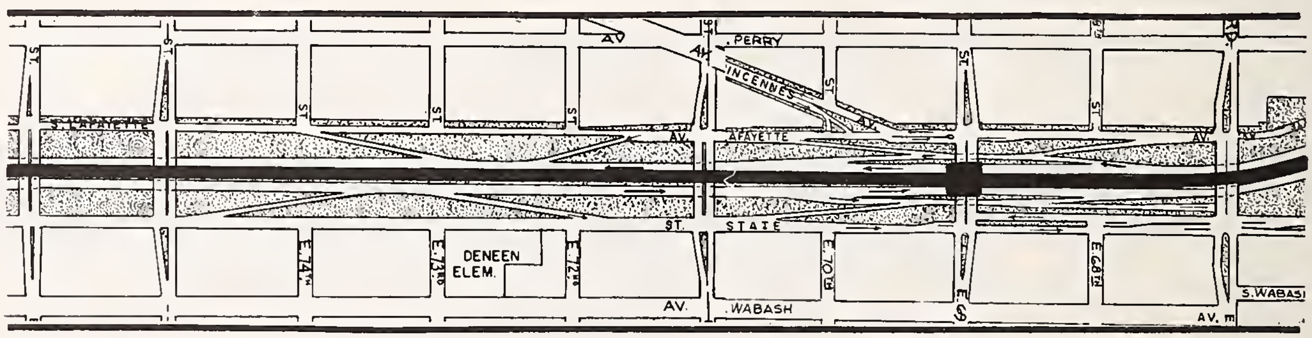
Structure

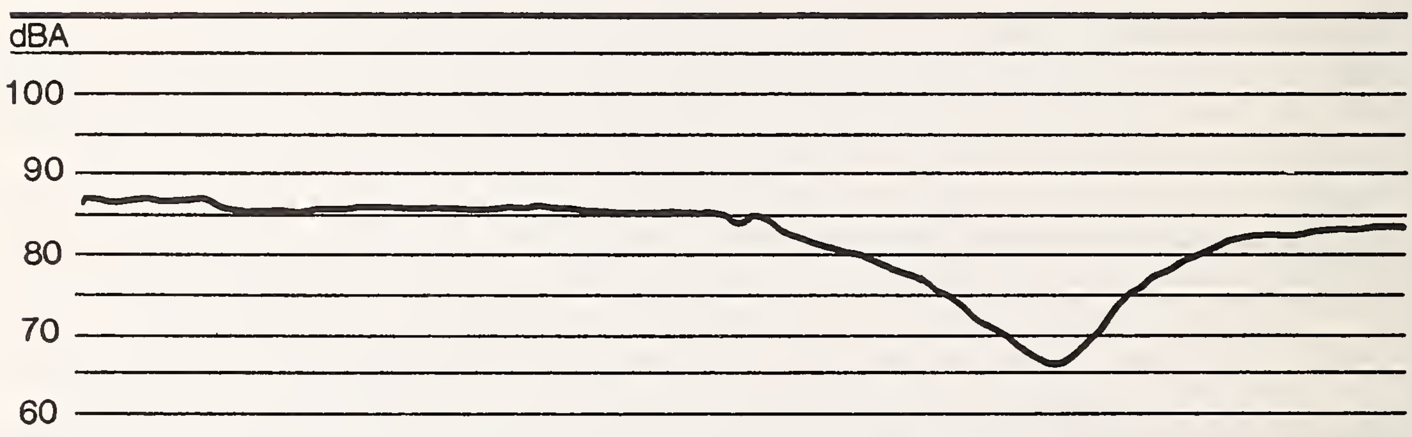
Geometry

Track

Station

69 TH (AB)





Speed (MPH) 46 35 0 35

Sources

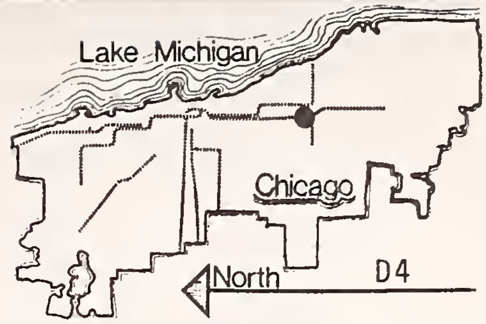
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: 66th ST. -56th ST.

2 CAR 2200 SERIES



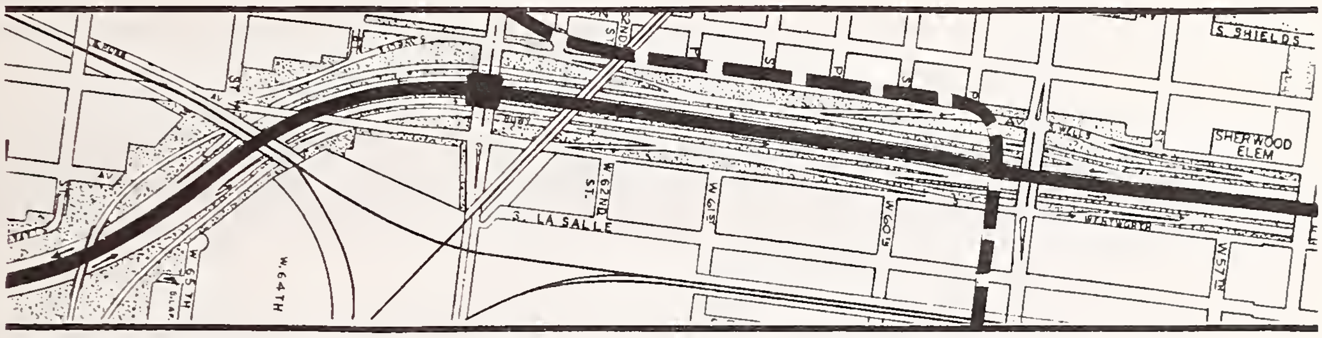
Structure

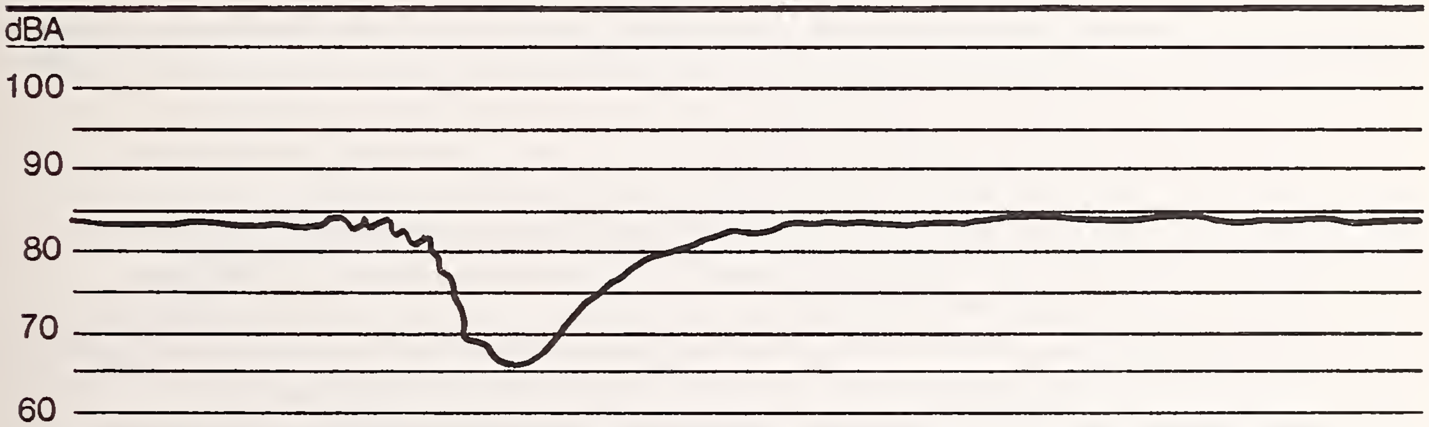
Geometry

Track

Station

63 TH (A)





Speed (MPH)	35	0	35

Sources

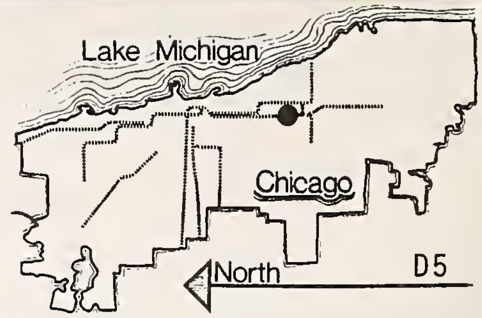
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: 57th ST. - SWANN ST.

2 CAR 2200 SERIES



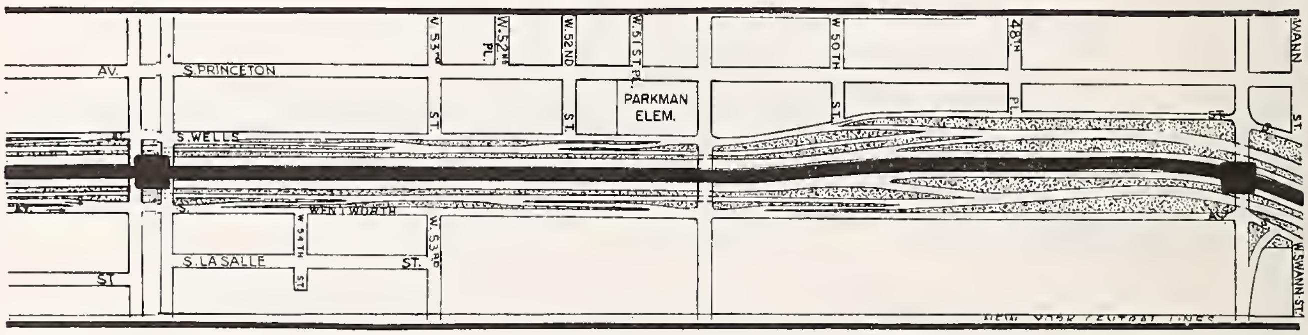
Structure

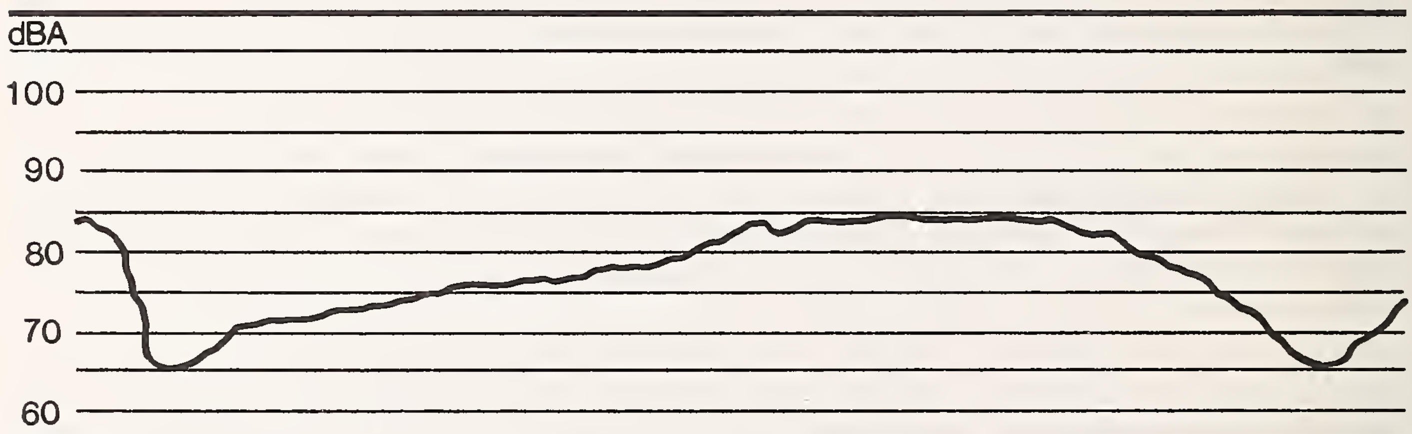
Geometry

Track

Station

GARFIELD (B) 47 TH (A)





Speed (MPH) 0 25 30 0

Sources

Paths

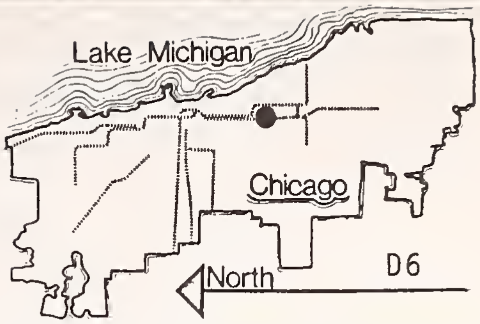
IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT:

SWANN ST.- 37th ST.

2 CAR 2200 SERIES

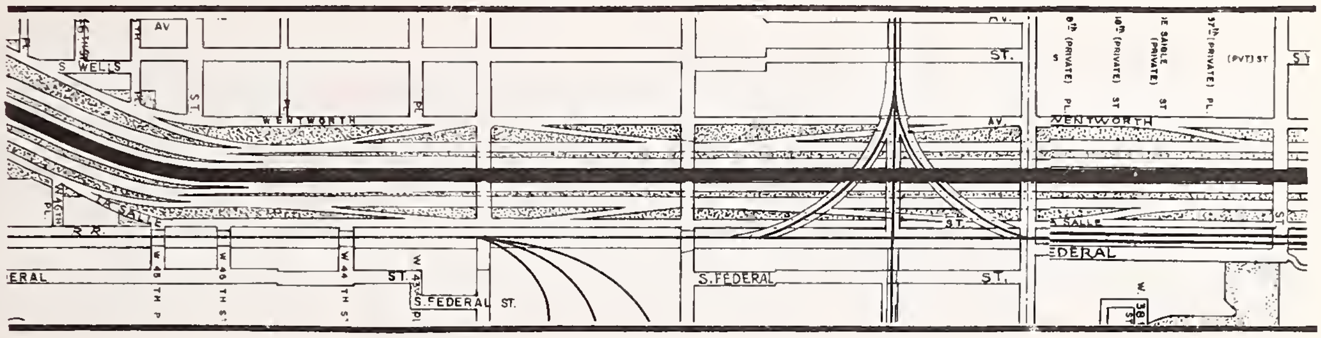


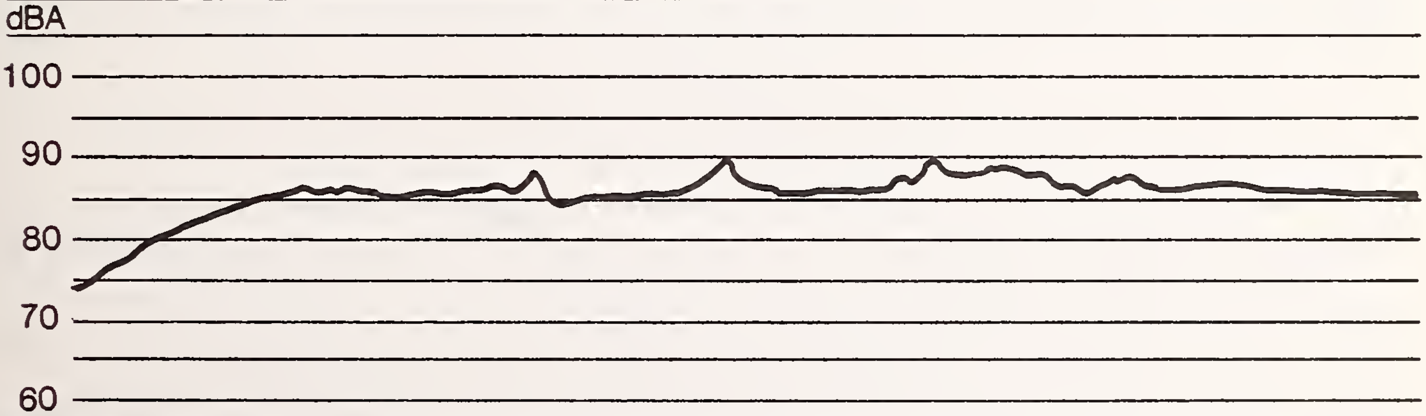
Structure

Geometry

Track

Station





Speed (MPH) 25 50

Sources

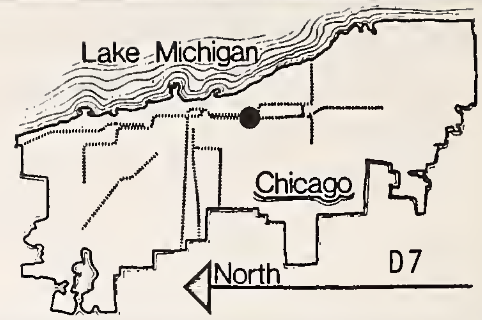
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **DAN RYAN SERVICE**

SEGMENT: 37th ST. - 26th ST.

2 CAR 2200 SERIES



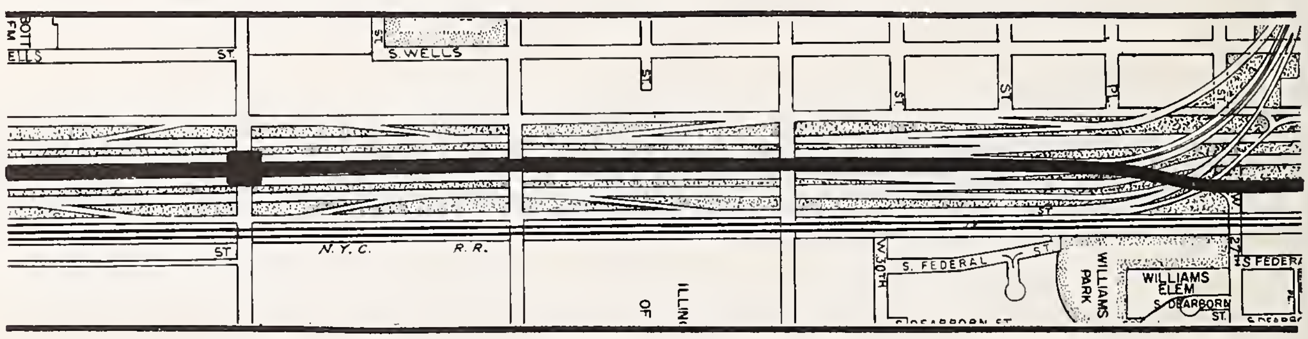
Structure

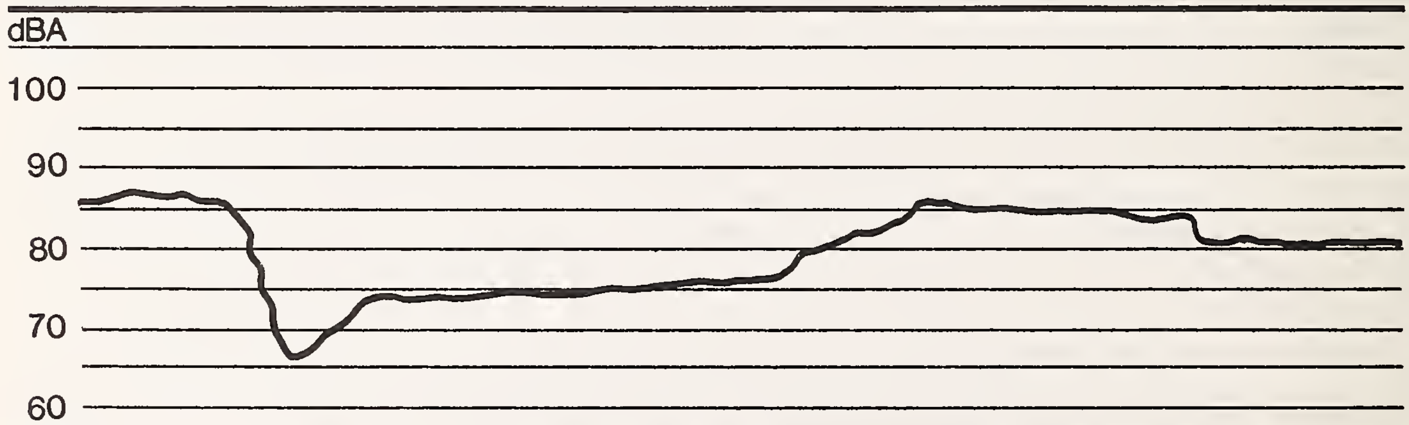
Geometry

Track

Station

35 TH (AB)





Speed (MPH) 36 0 26 33 30 30

Sources

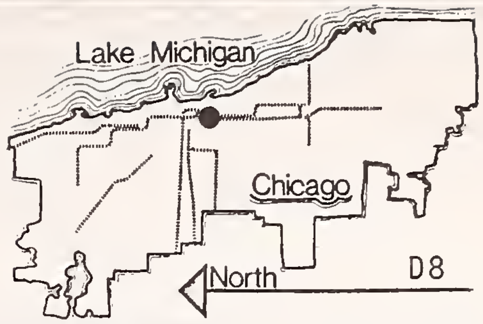
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: 26th ST. - 15th ST.

2 CAR 2200 SERIES



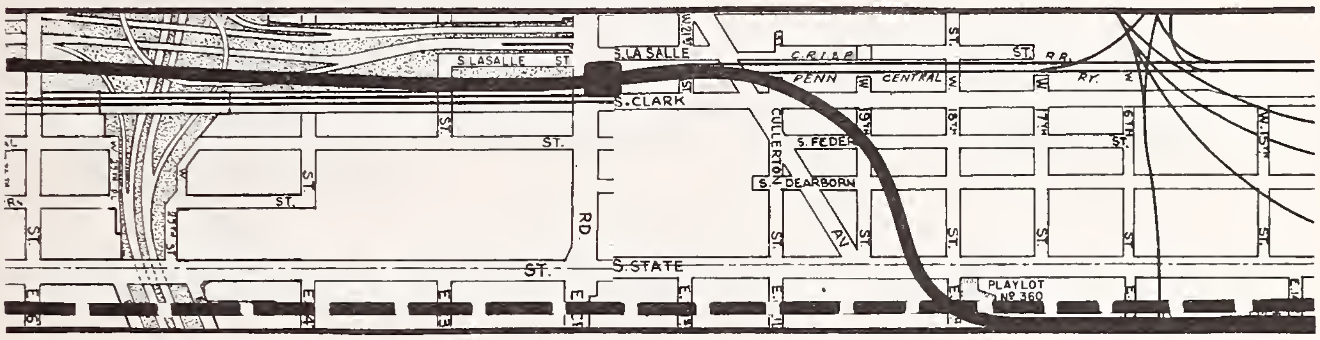
Structure

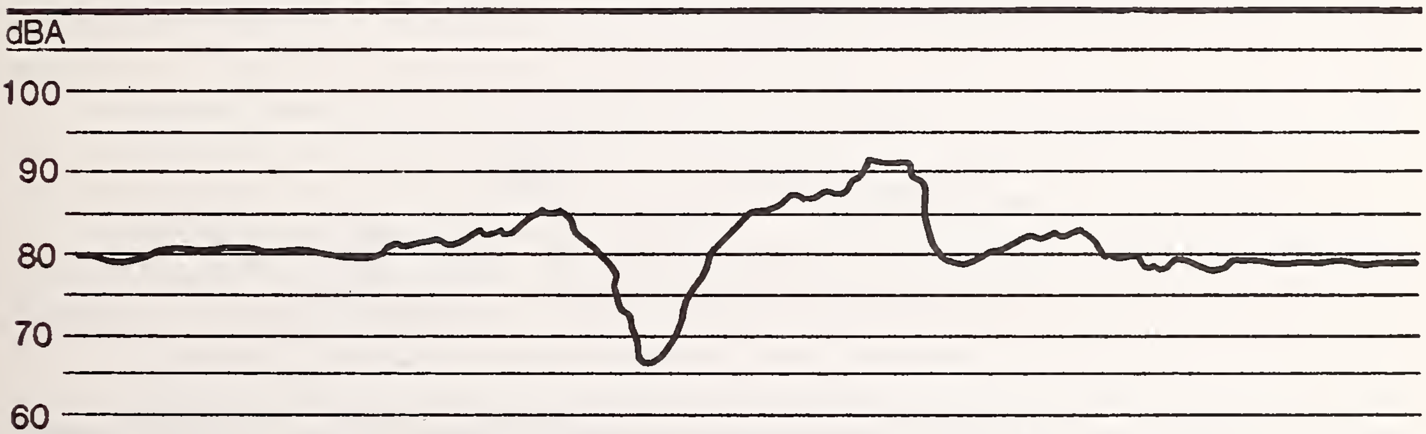
Geometry

Track

Station

CERMAK (B)





Speed (MPH) 30 0 20 15

Sources

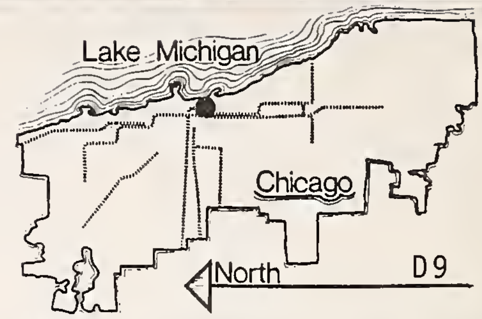
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: 14th STREET - MONROE ST.

2 CAR 2200 SERIES



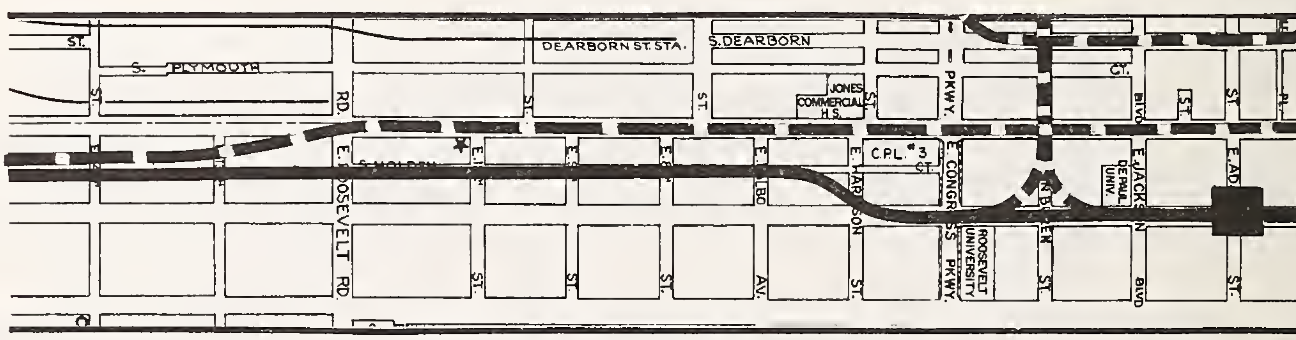
Structure

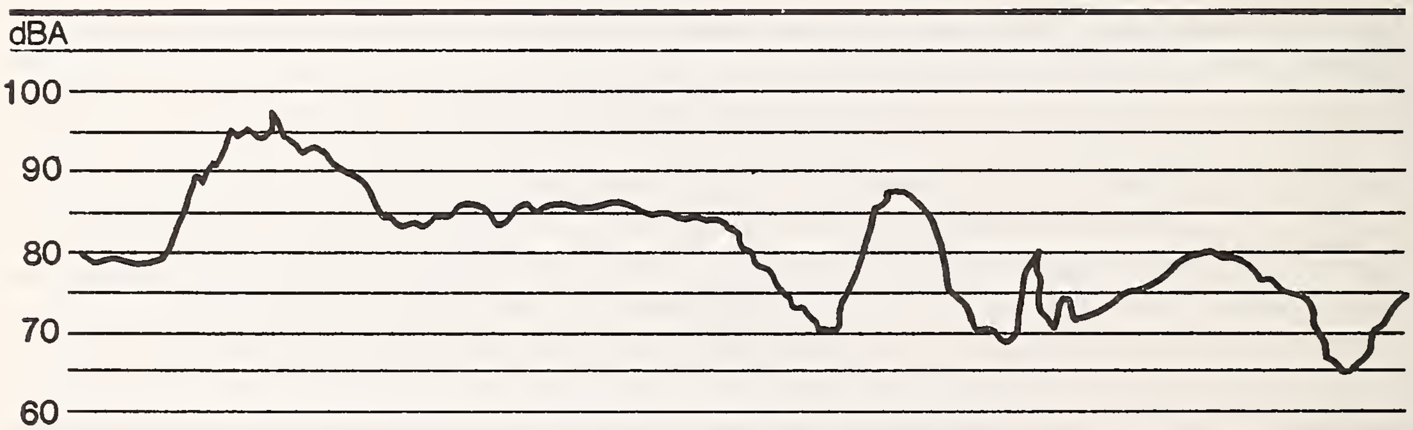
Geometry

Track

Station

ADAMS





Speed (MPH) 25 25 15 10 10 0

Sources

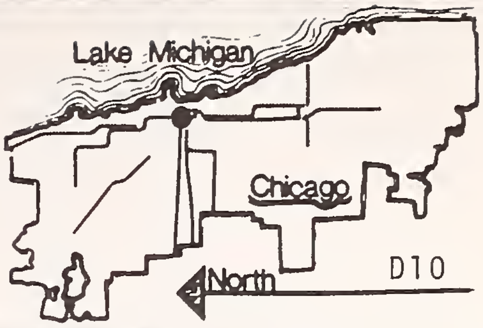
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: DAN RYAN SERVICE

SEGMENT: MONROE ST. - DEARBORN ST.

2 CAR 2200 SERIES



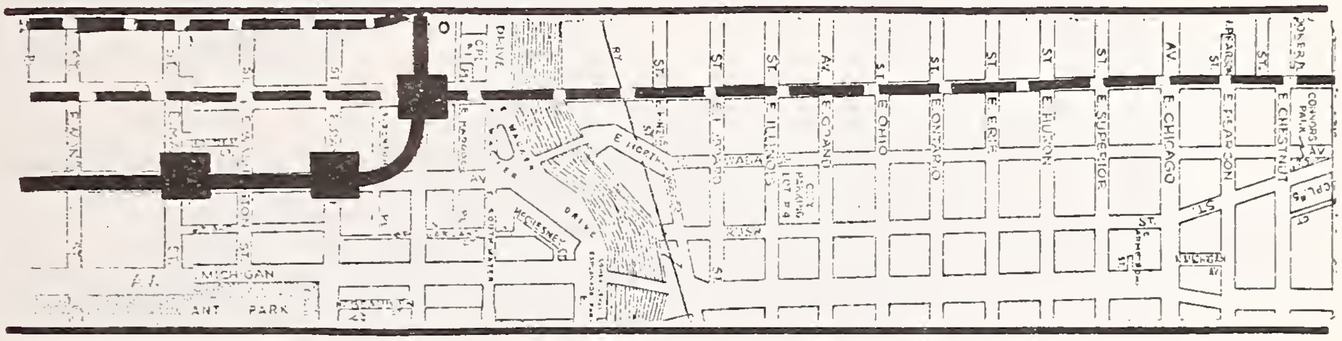
Structure →

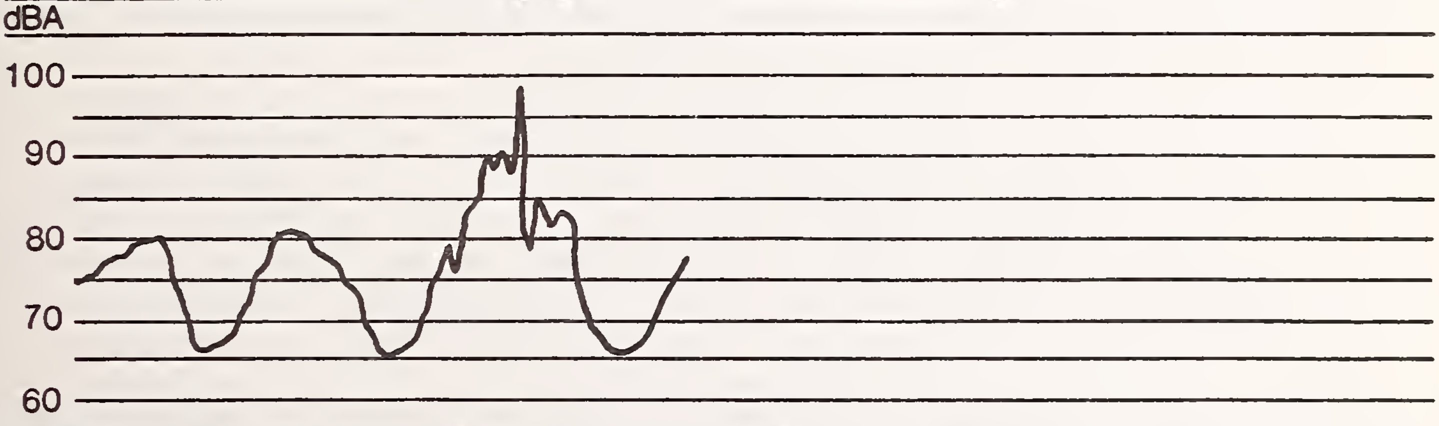
Geometry →

Track →

Station

MADISON RADOLPH STATE





Speed (MPH) 25 0 25 0 10 0

Sources → →

→

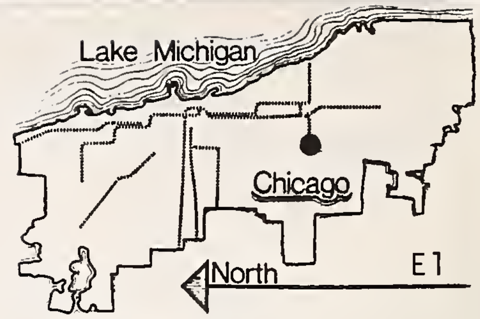
Paths → → →

IN-CAR NOISE MEASUREMENT

ROUTE: ENGLEWOOD SERVICE

SEGMENT: ASHLAND AVE. - EGGLESTON AVE.

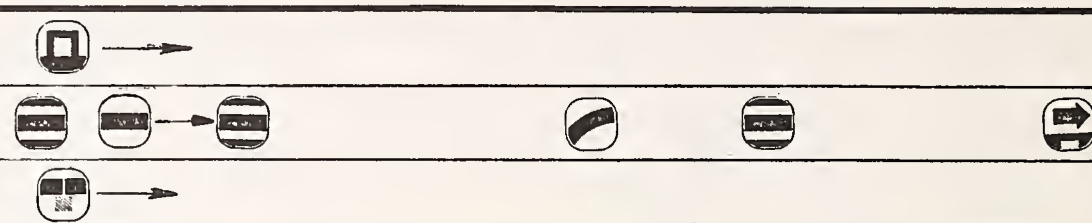
4 CAR 6000 SERIES



Structure

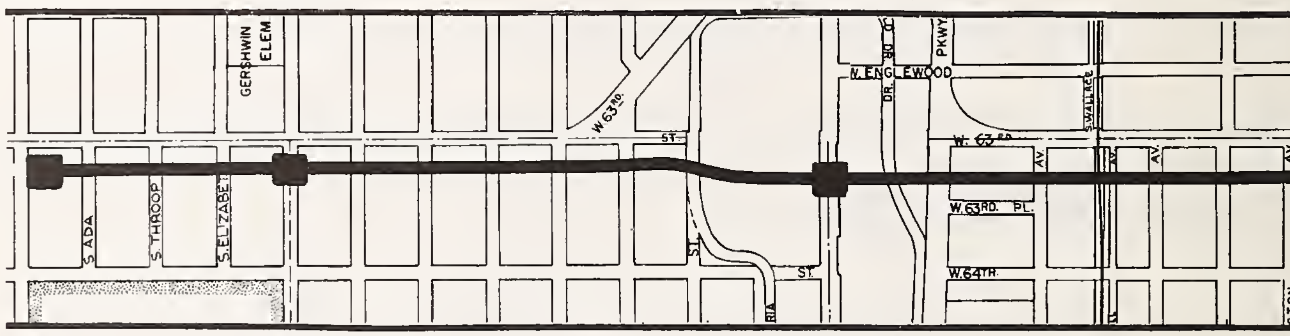
Geometry

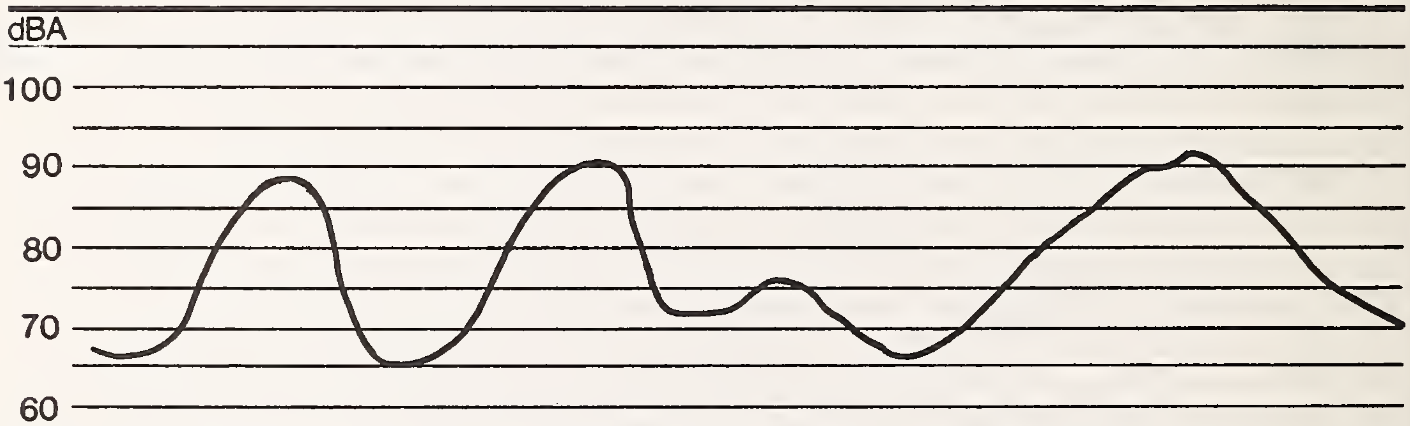
Track



Station

ASHLAND (A) RACINE (A) HALSTED (A)

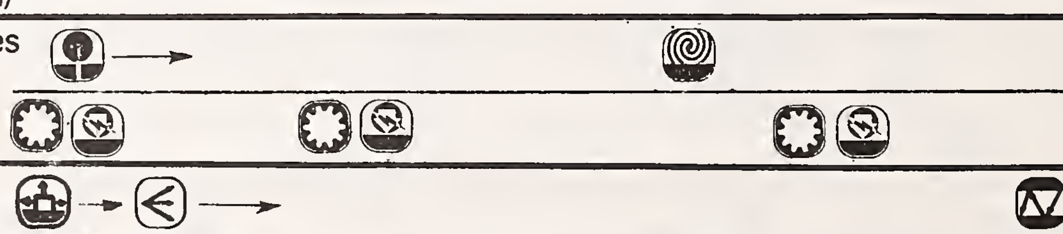




Speed (MPH) 0 25 0 33 18 0 28 32 10

Sources

Paths

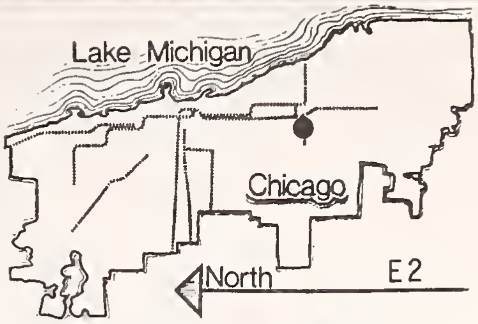


IN-CAR NOISE MEASUREMENT

ROUTE: ENGLEWOOD SERVICE

SEGMENT: EGGLESTON AVE. - LA SALLE AVE.

4 CAR 6000 SERIES



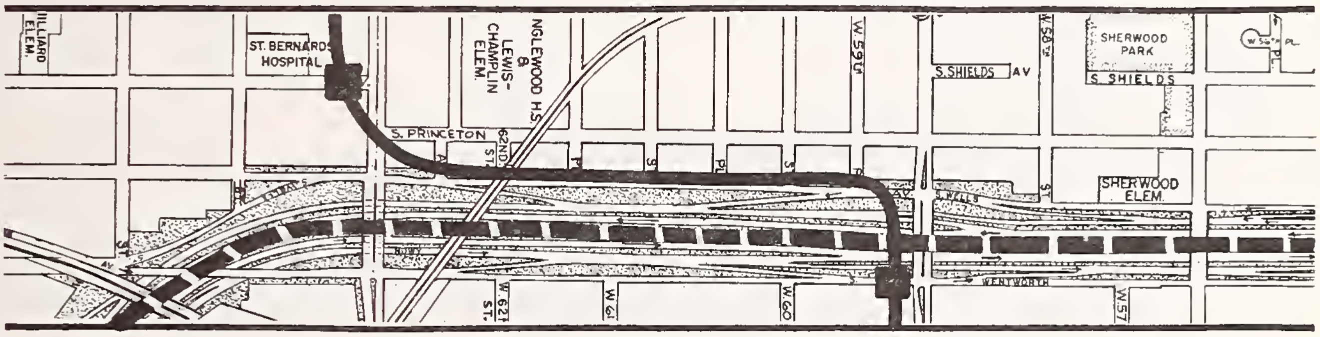
Structure

Geometry

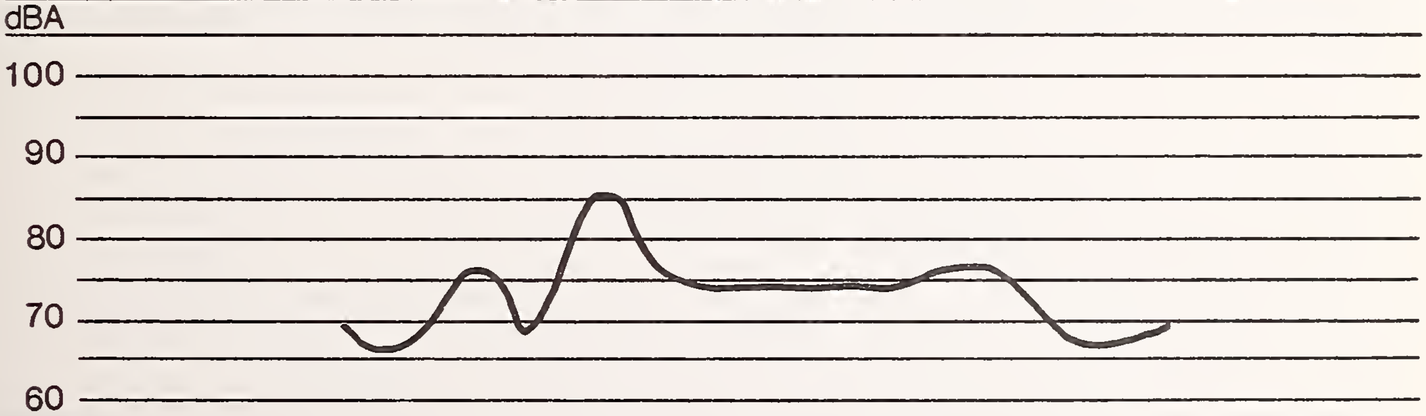
Track

Station

HARVARD (A) WENTWORTH (A)



dBA



Speed (MPH) 0 8 10 12 12 0

Sources

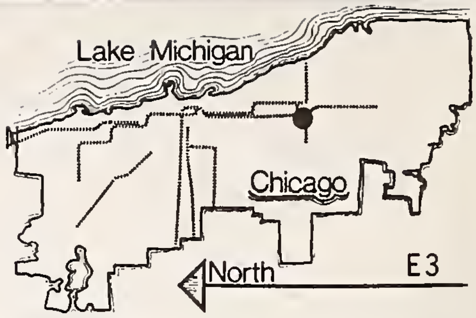
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: **ENGLEWOOD SERVICE**

SEGMENT: LA SALLE AVE. - JACKSON PARK JUNCTION

4 CAR 6000 SERIES

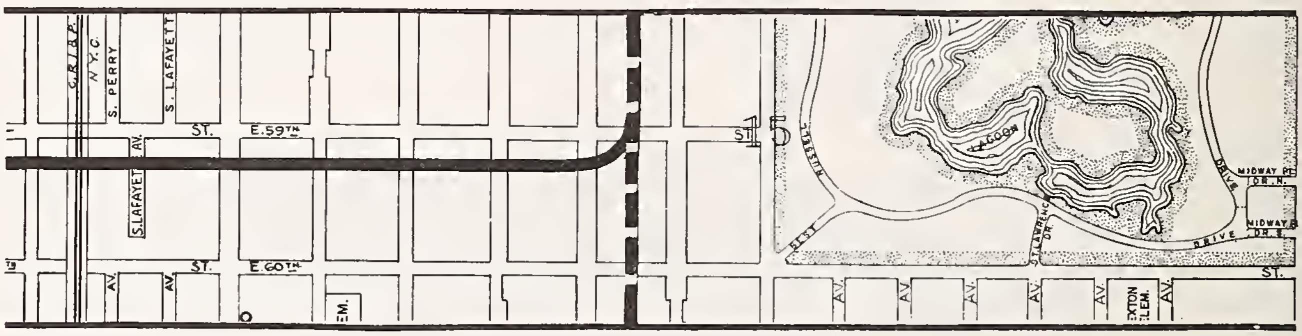


Structure

Geometry

Track

Station



dBA

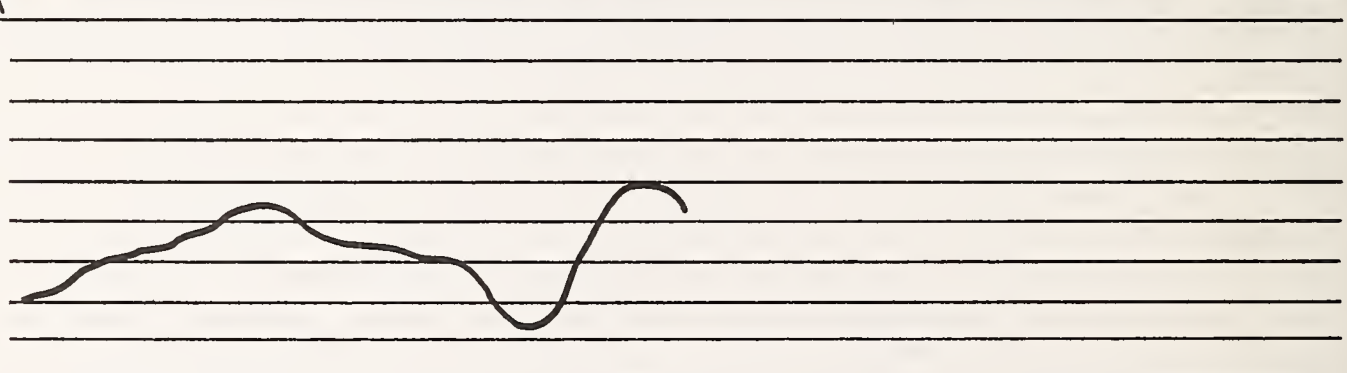
100

90

80

70

60



Speed (MPH) 0 27 20 11 29

Sources

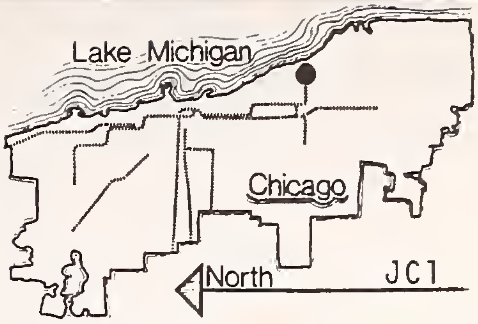
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: JACKSON PARK SERVICE

SEGMENT: COTTAGE GROVE AVE. - JACKSON PARK

4 CAR 6000 SERIES

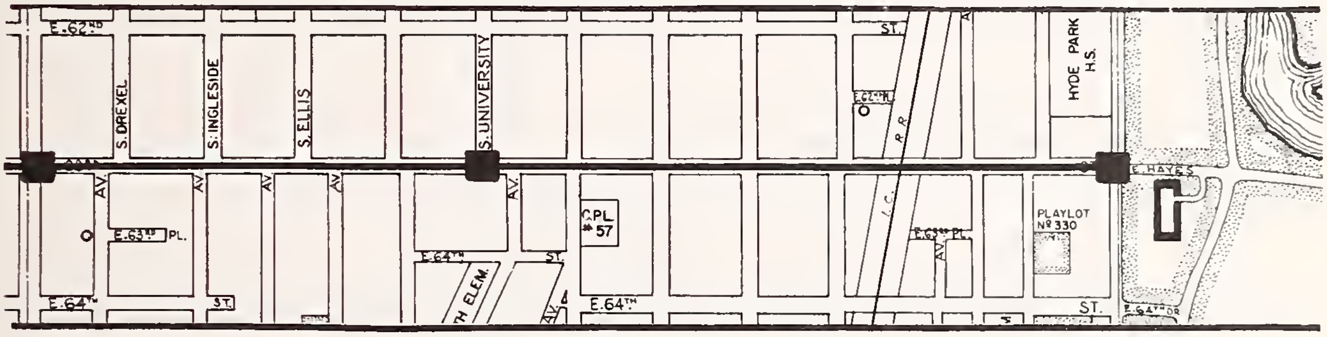


Structure

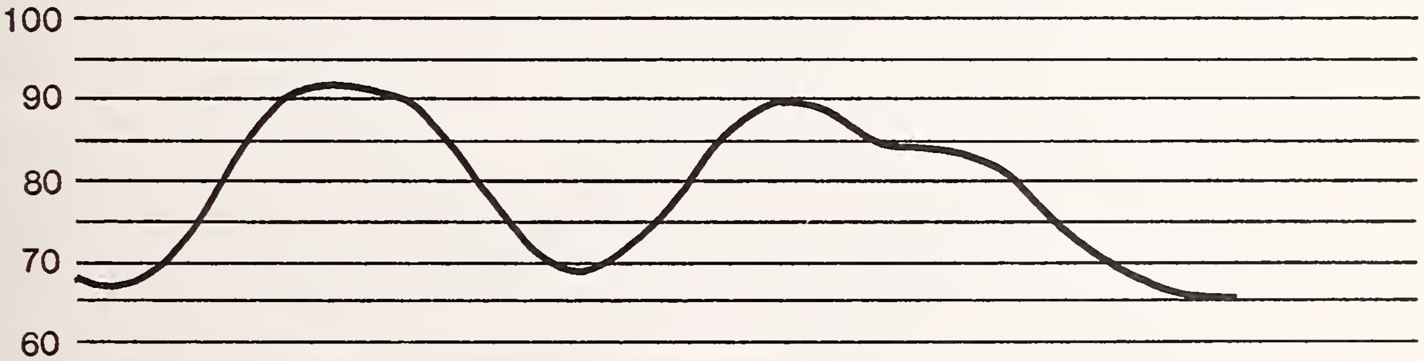
Geometry

Track

Station COTTAGE GROVE (B) UNIVERSITY (B) JACKSON PK (B)



dBA



Speed (MPH) 30 0 28 0

Sources

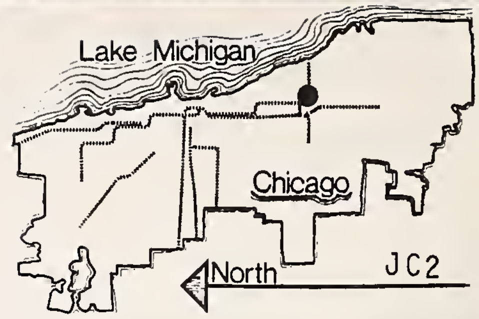
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: JACKSON PARK SERVICE

SEGMENT: KING DRIVE - COTTAGE GROVE AVE.

4 CAR 6000 SERIES



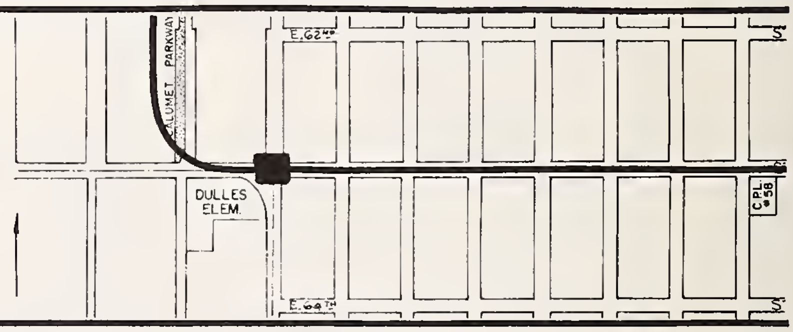
Structure

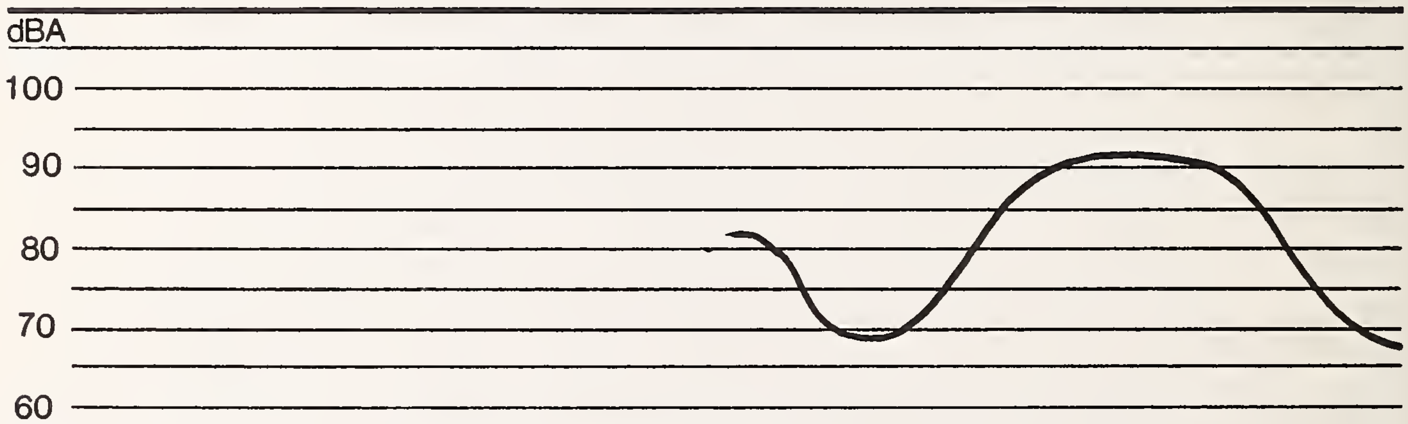
Geometry

Track

Station

KING DR (B)





Speed (MPH) 13 0 30 0

Sources

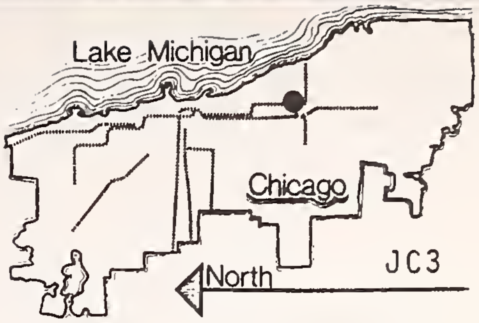
Paths

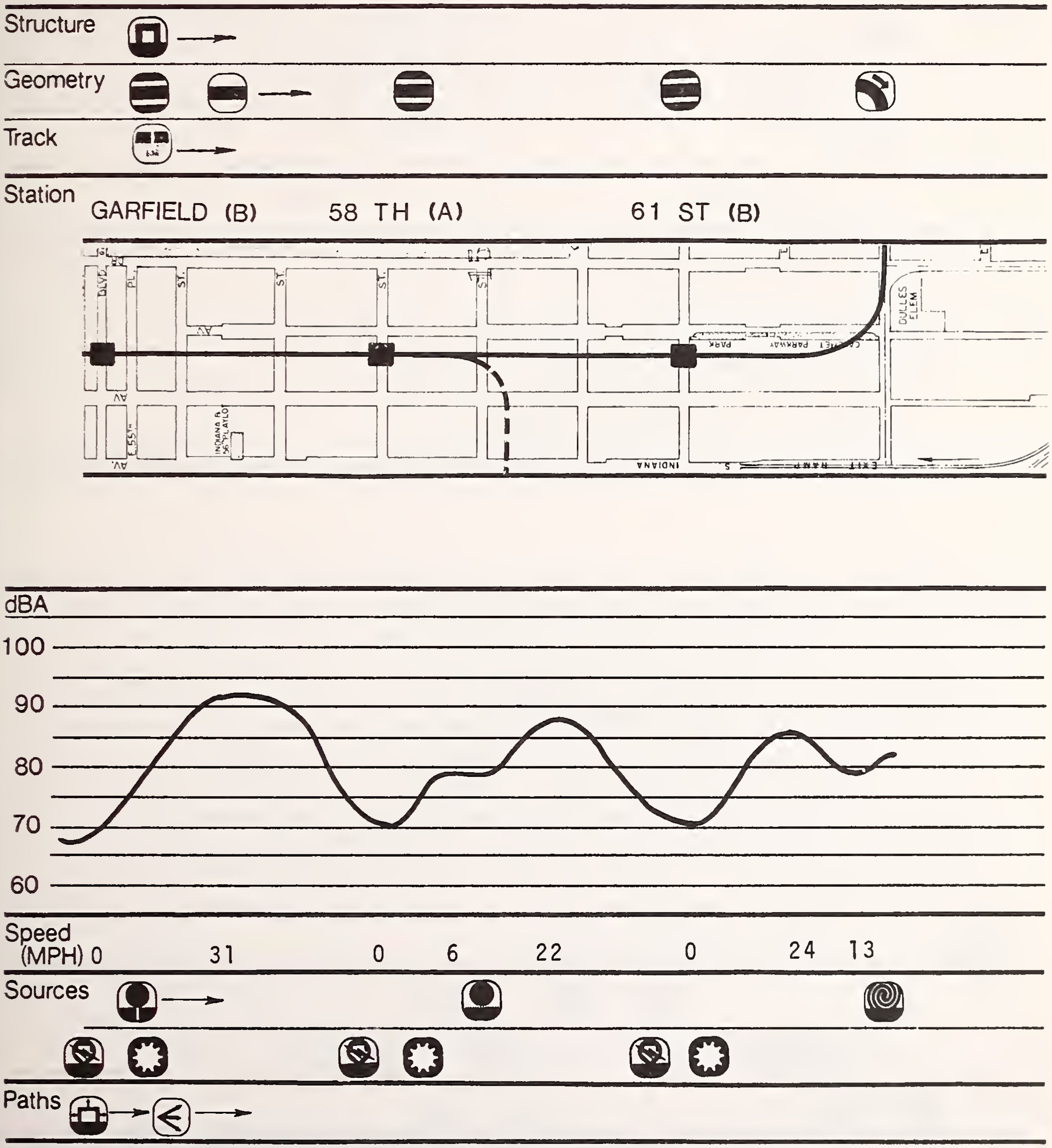
IN-CAR NOISE MEASUREMENT

ROUTE: **JACKSON PARK SERVICE**

SEGMENT: GARFIELD BLVD. - KING DRIVE

4 CAR 6000 SERIES



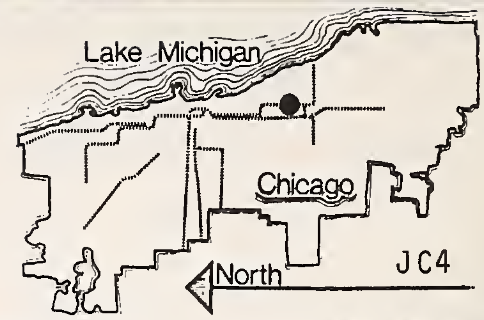


IN-CAR NOISE MEASUREMENT

ROUTE: **JACKSON PARK SERVICE**

SEGMENT: 45th STREET - GARFIELD BLVD.

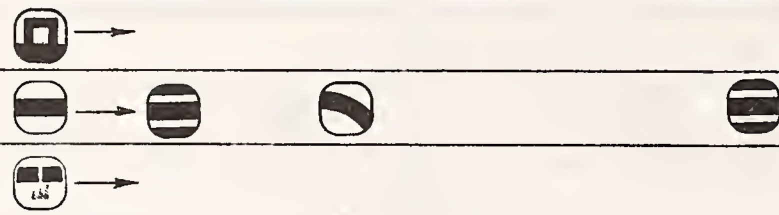
4 CAR   6000 SERIES



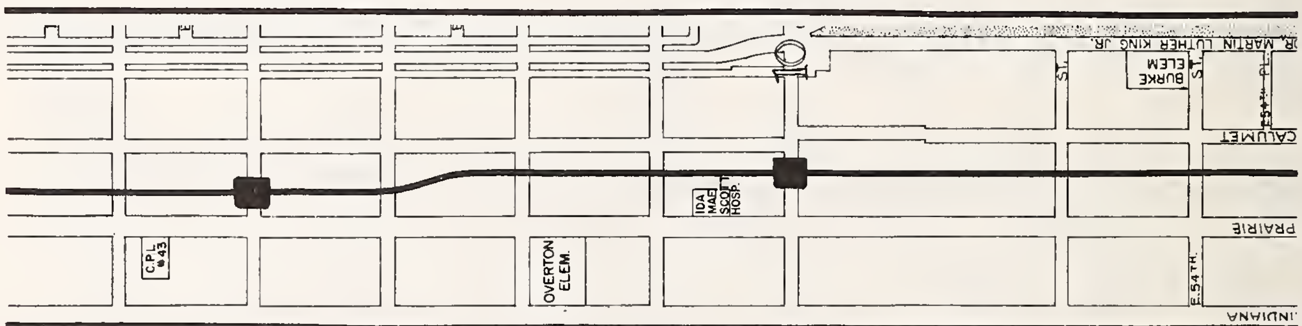
Structure

Geometry

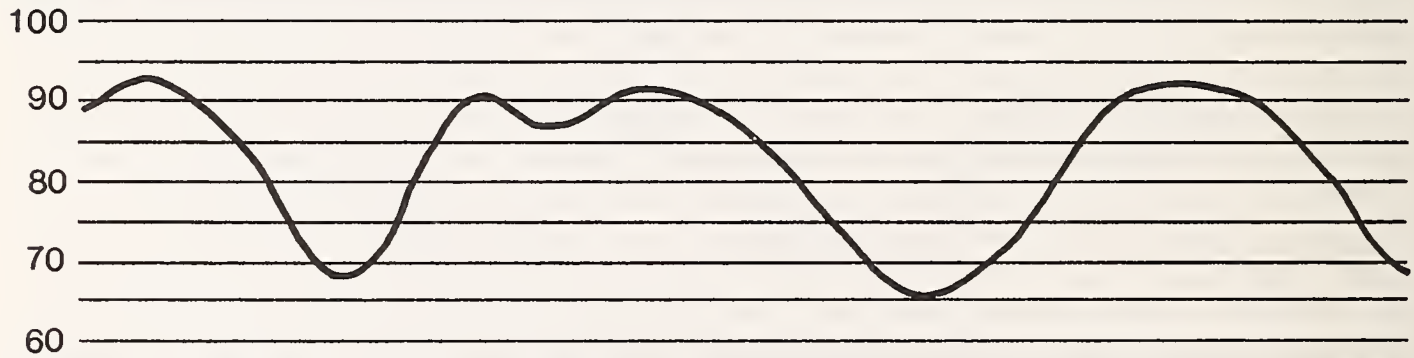
Track



Station   47 TH (AB)   51 ST (AB)

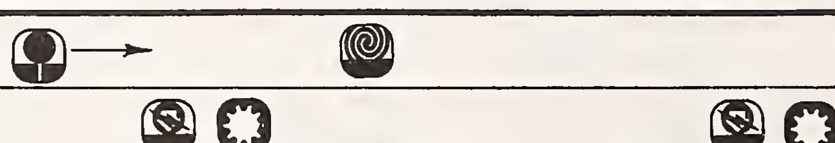


dBA

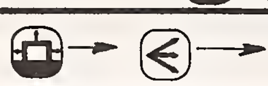


Speed (MPH) 38 0 30 35 0 32 0

Sources



Paths

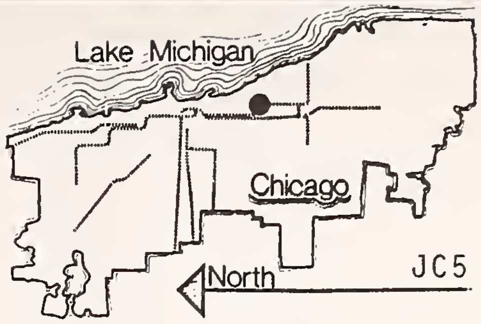


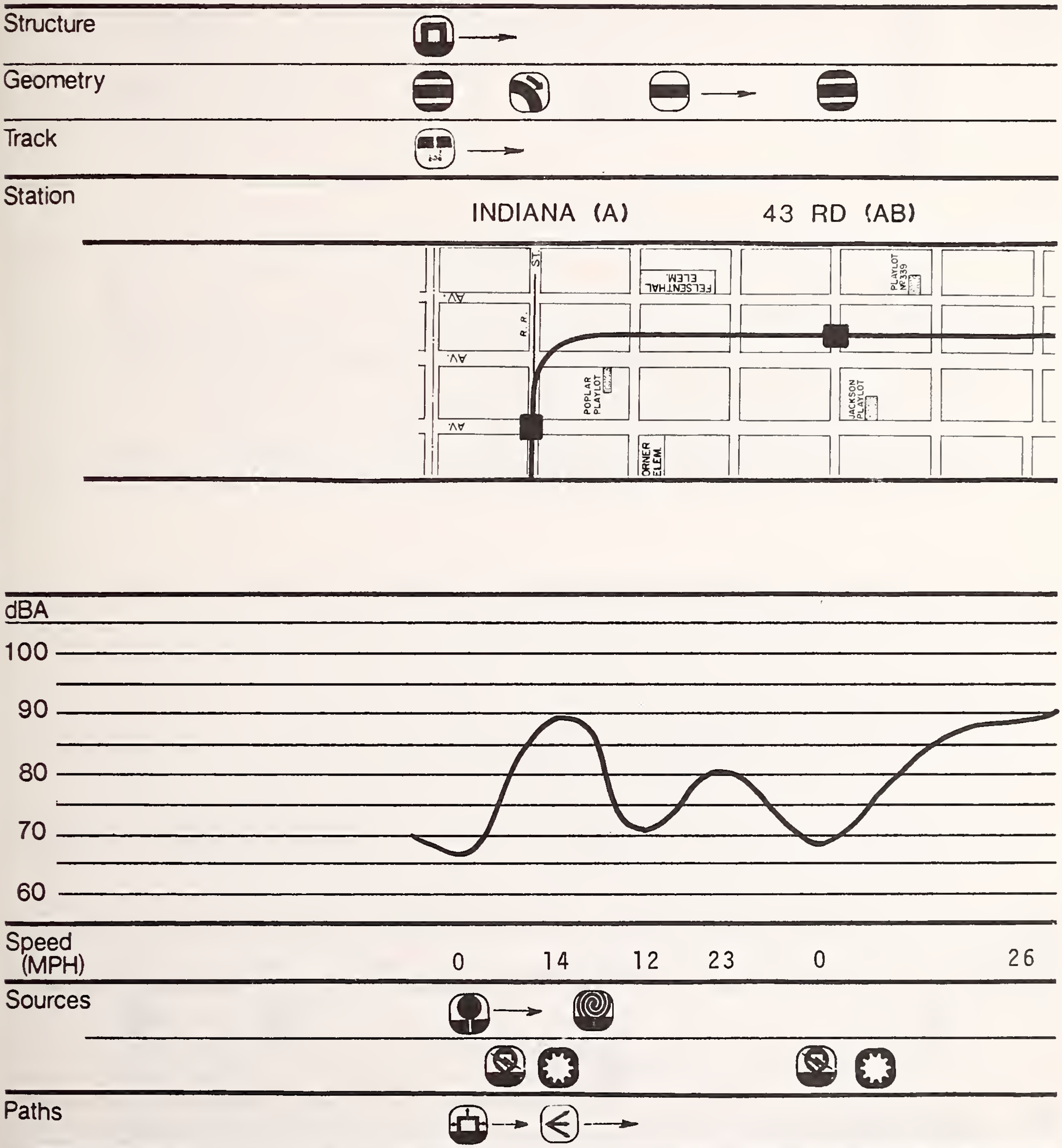
IN-CAR NOISE MEASUREMENT

ROUTE: JACKSON PARK SERVICE

SEGMENT: INDIANA ST. - 45th STREET

4 CAR 6000 SERIES



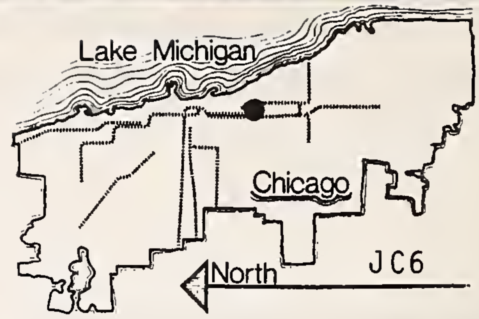


IN-CAR NOISE MEASUREMENT

ROUTE: **JACKSON PARK SERVICE**

SEGMENT: 32nd STREET - INDIANA ST.

4 CAR 6000 SERIES



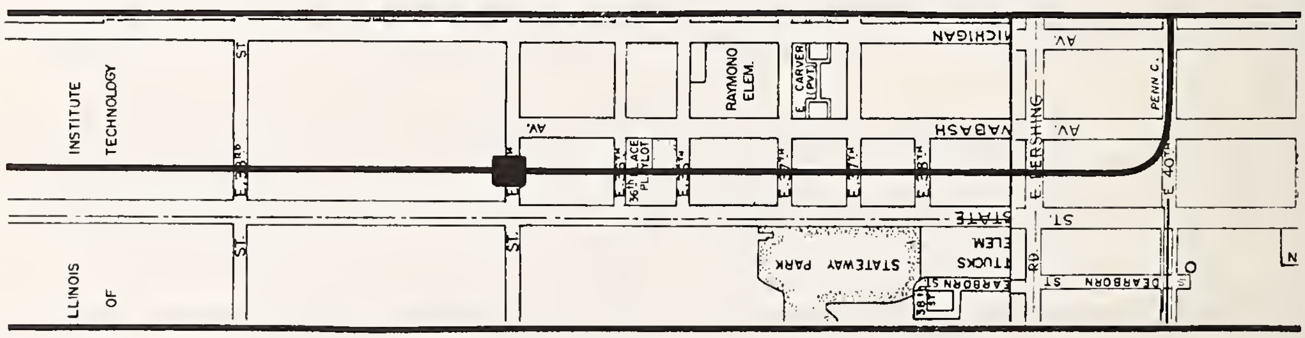
Structure

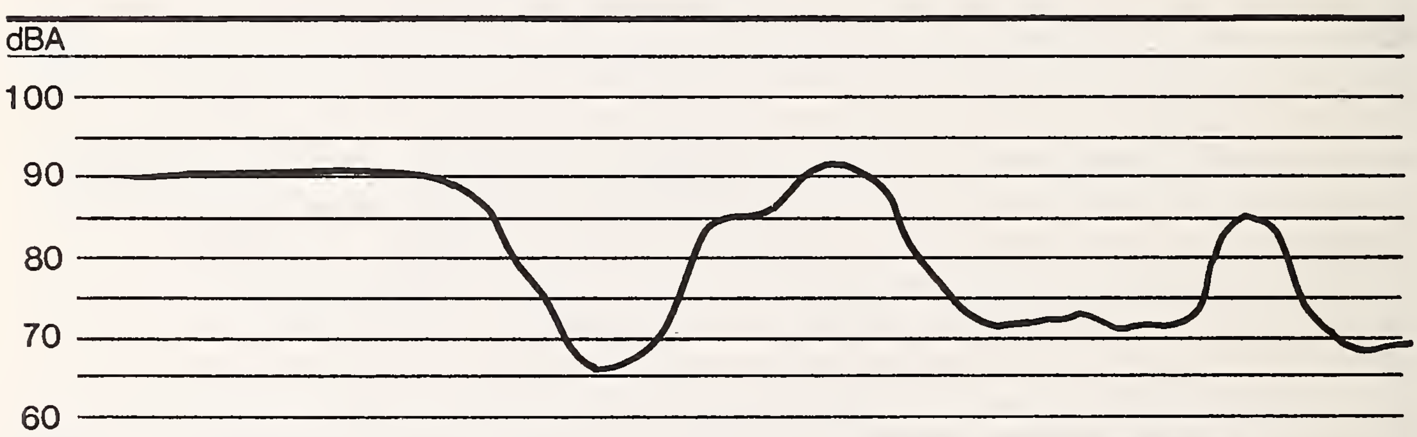
Geometry

Track

Station

TECH-35 (AB)





Speed (MPH) 37 36 0 33 36 10 11 10

Sources

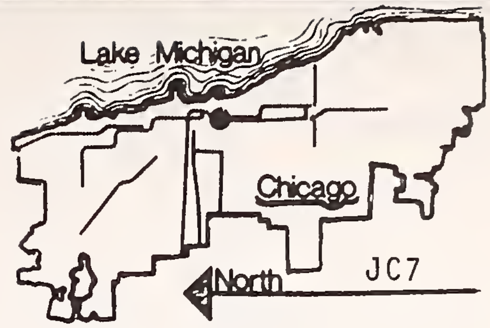
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: JACKSON PARK SERVICE

SEGMENT: 21st STREET - 32nd STREET

4 CAR 6000 SERIES



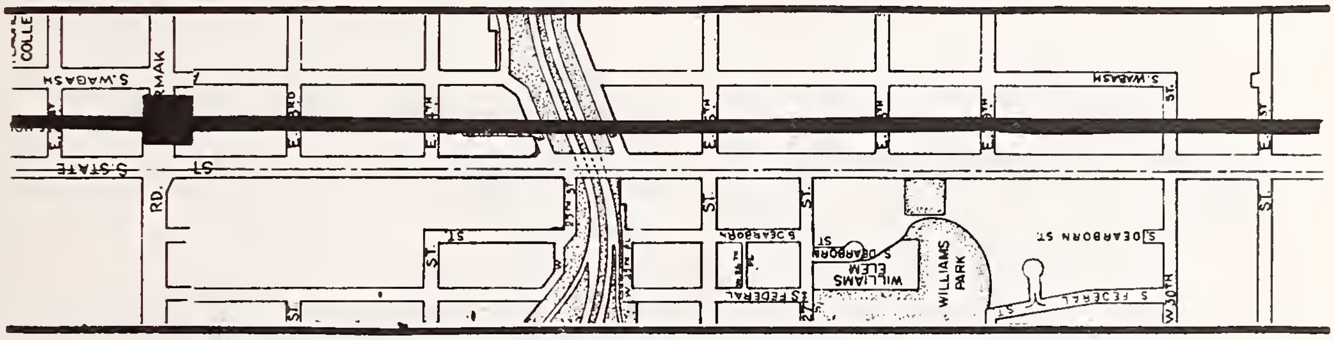
Structure

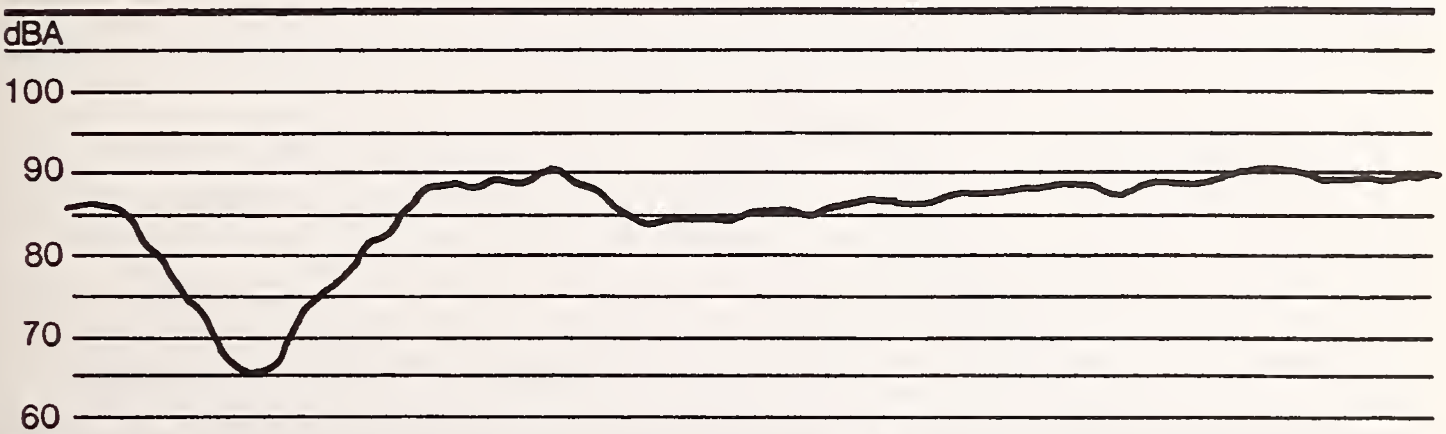
Geometry

Track

Station

CERMAK (B)





Speed (MPH)	0	37	36	38

Sources

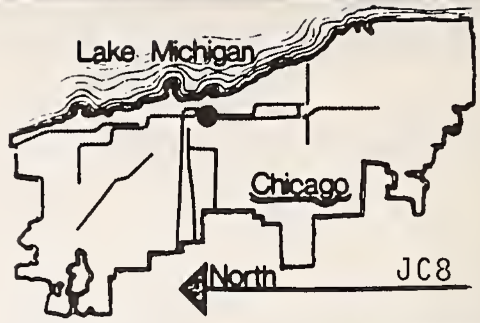
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: JACKSON PARK SERVICE

SEGMENT: HARRISON ST. - 32nd ST.

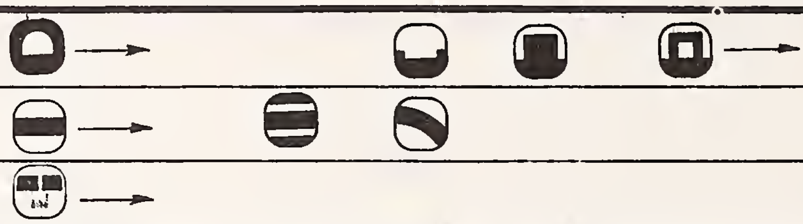
4 CAR 6000 SERIES



Structure

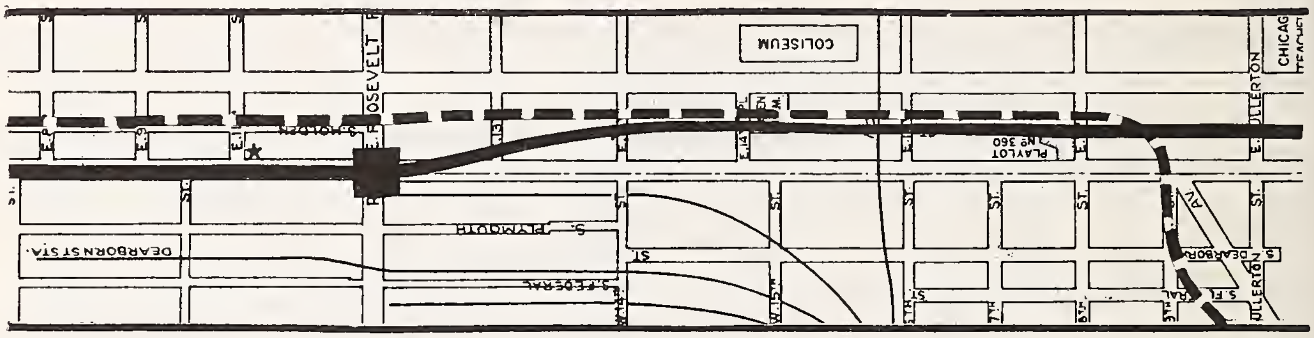
Geometry

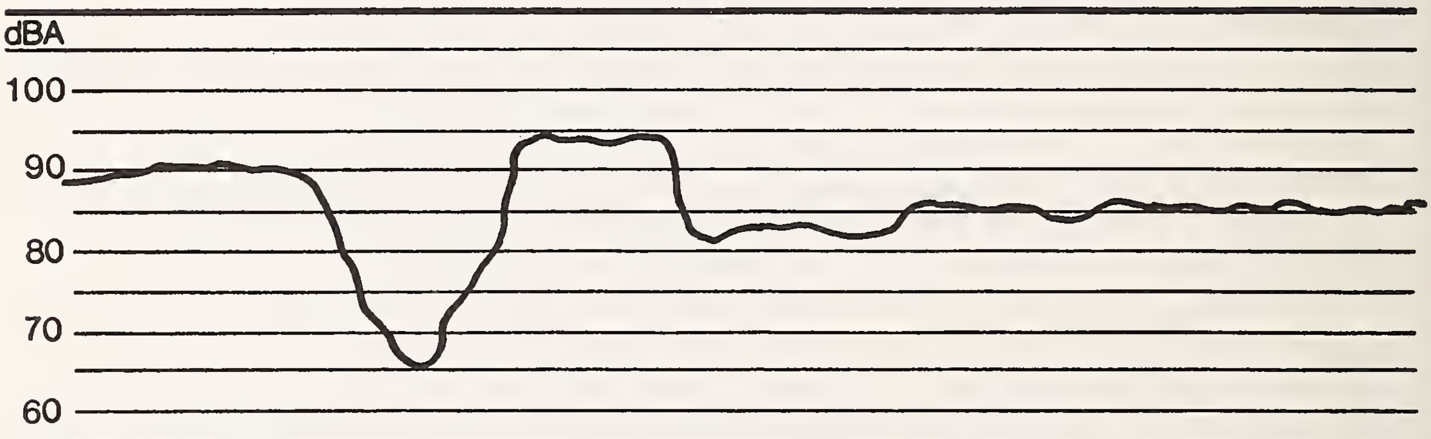
Track



Station

ROOSEVELT (AB)





Speed (MPH) 30 0 32 35 38

Sources

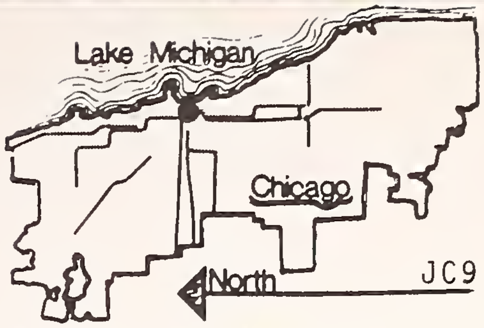
Paths

IN-CAR NOISE MEASUREMENT

ROUTE: JACKSON PARK SERVICE

SEGMENT: HUBBARD STREET - HARRISON STATION

4 CAR 6000 SERIES

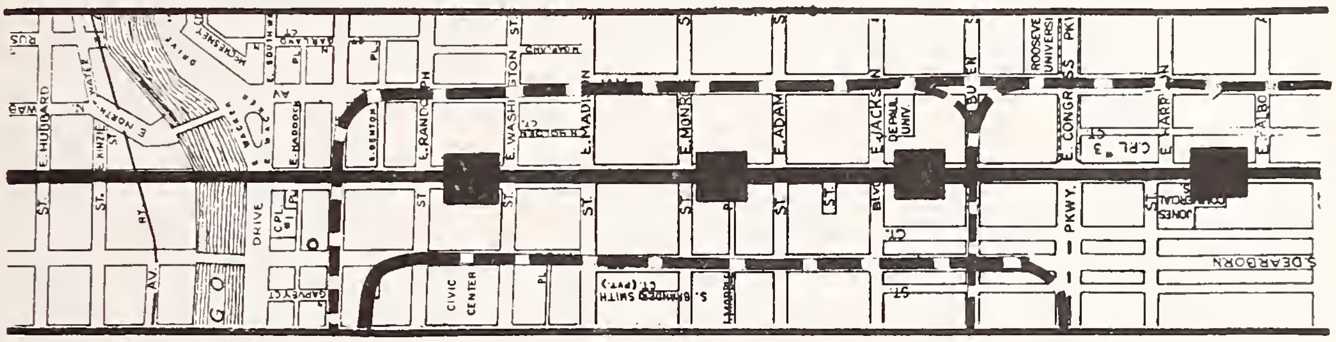


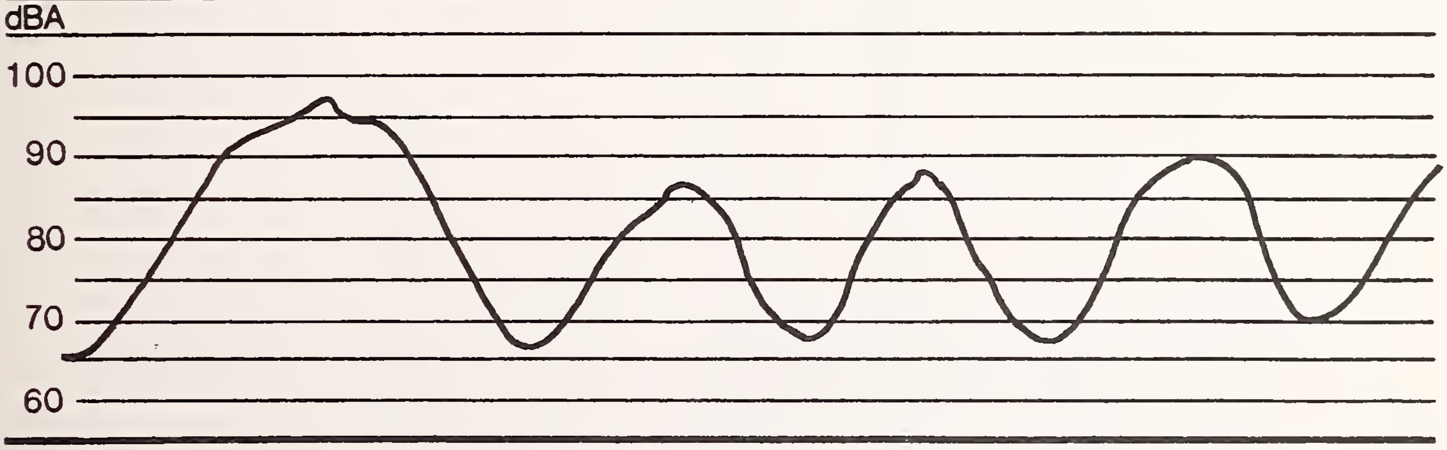
Structure

Geometry

Track

Station: WASHINGTON MONROE JACKSON HARRISON





Speed (MPH)	0	37	0	30	0	29	0	31	0

Sources

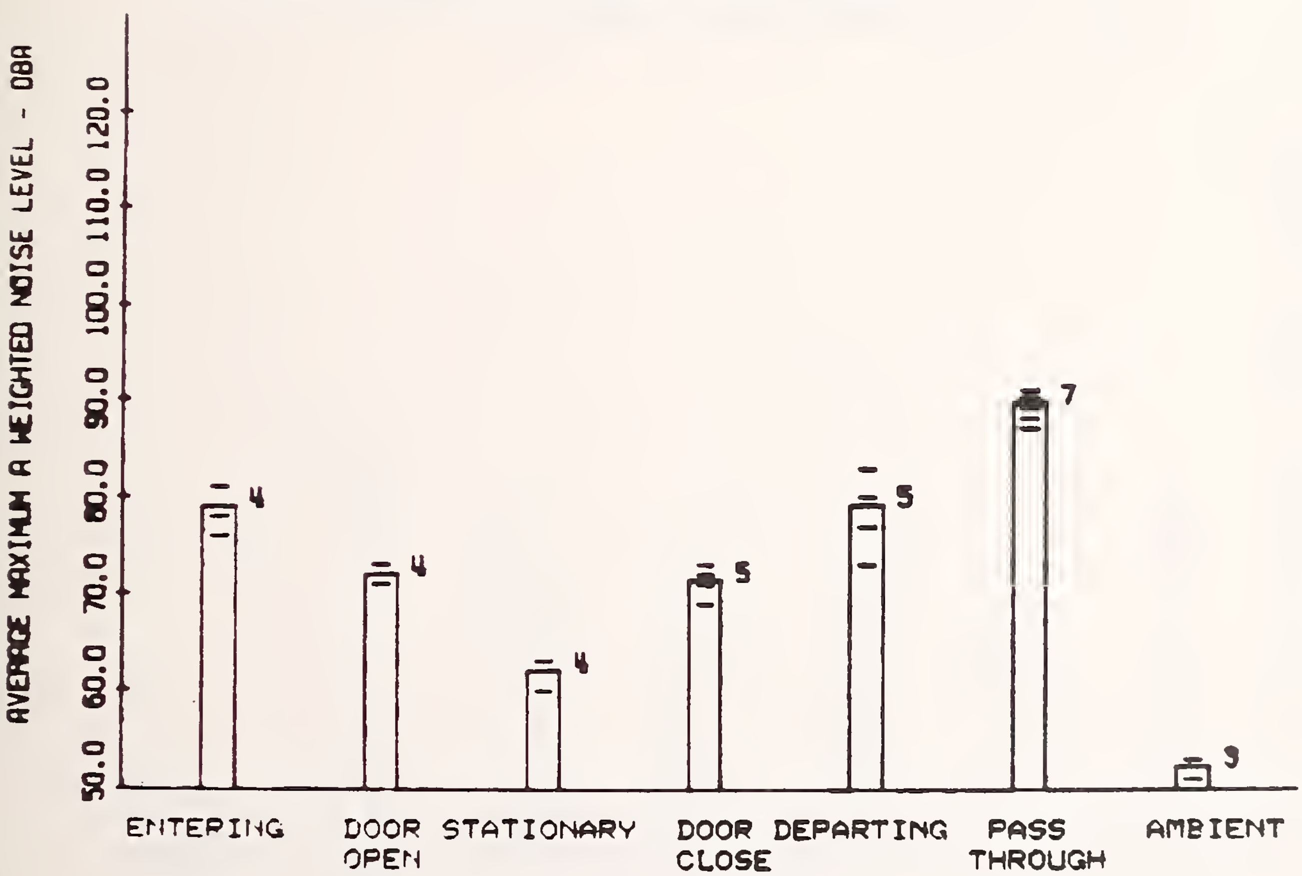
Paths

APPENDIX D

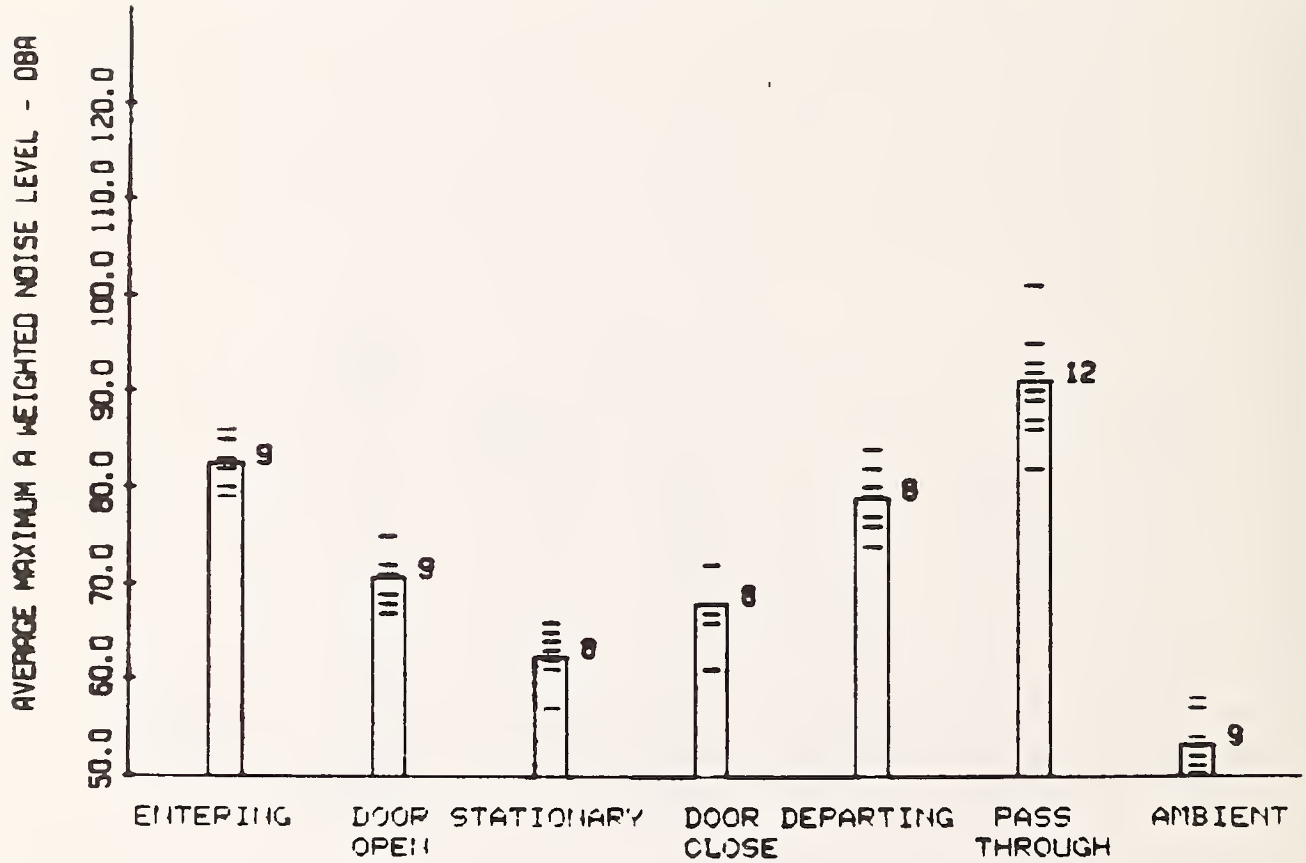
IN-STATION NOISE LEVELS VERSUS PHASE OF TRAIN OPERATION

STATION-ARGYLE
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: A(B TRAINS PASS THROUGH)

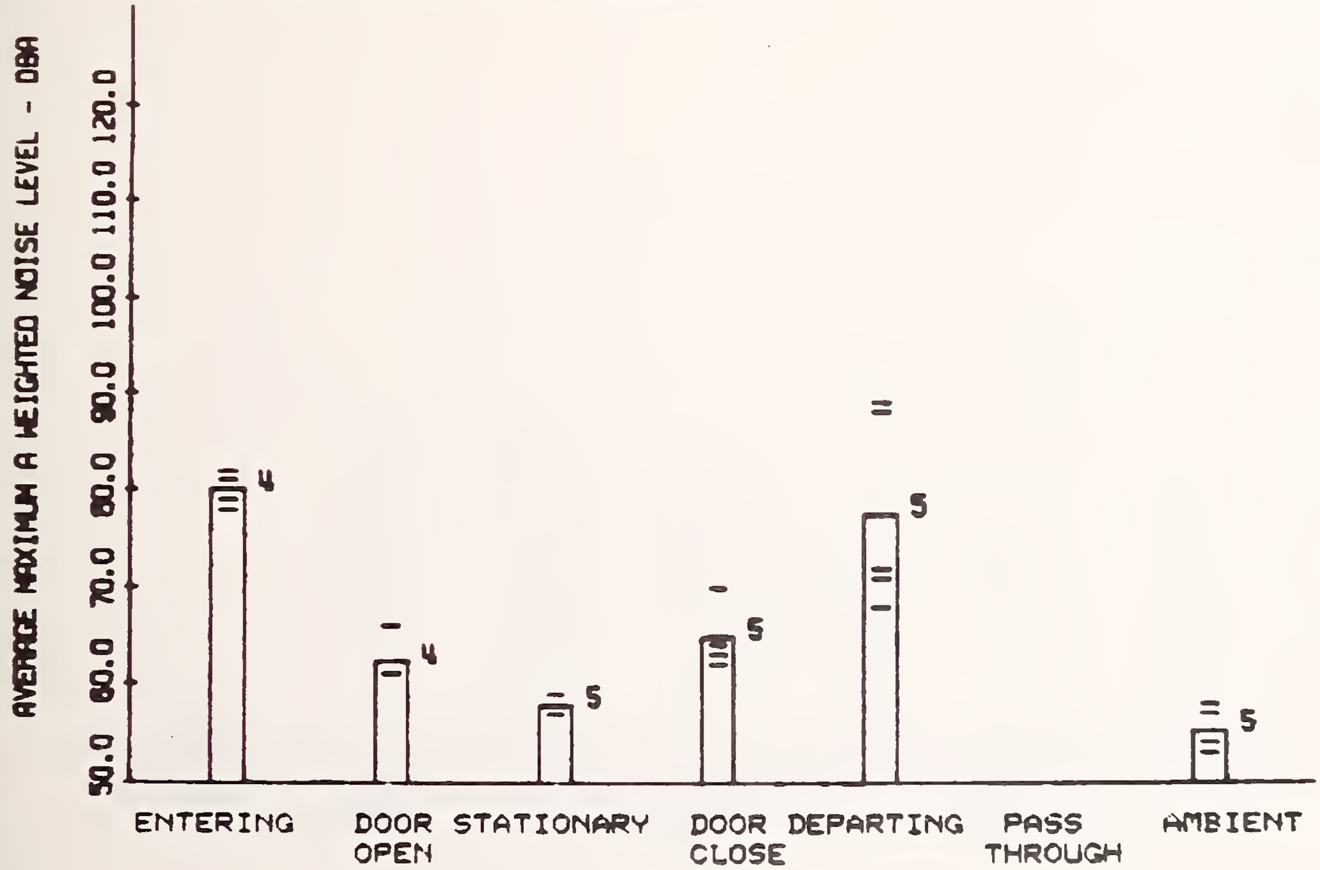
NO OF CARS: 4
TRAIN TYPE: 6000



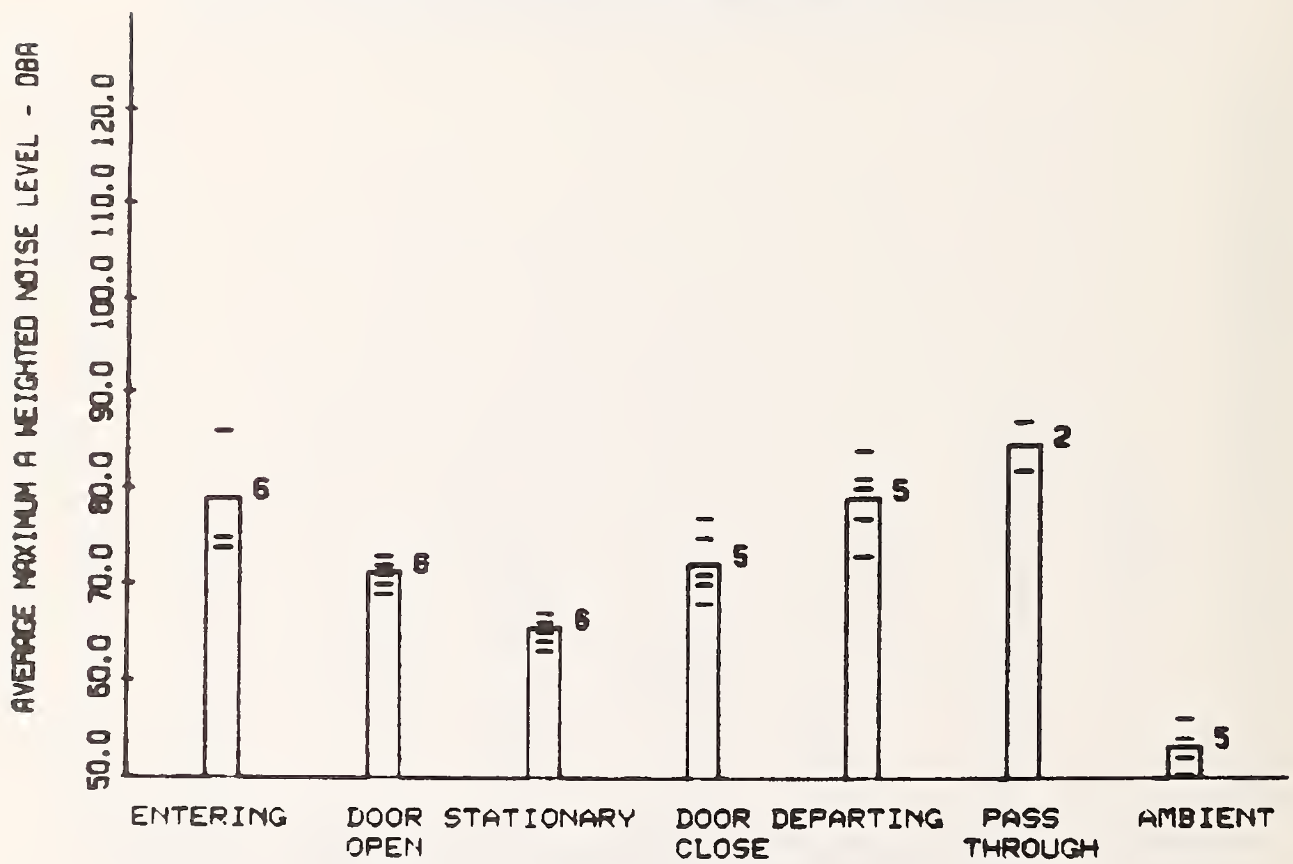
STATION-BELMONT
TRACK TYPE: WELDED RAIL WITH CONCRETE TIE   NO OF CARS: 2
STRUCTURE TYPE: SUBWAY TUNNEL   TRAIN TYPE: 2200
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: B(A TRAINS PASS THROUGH)



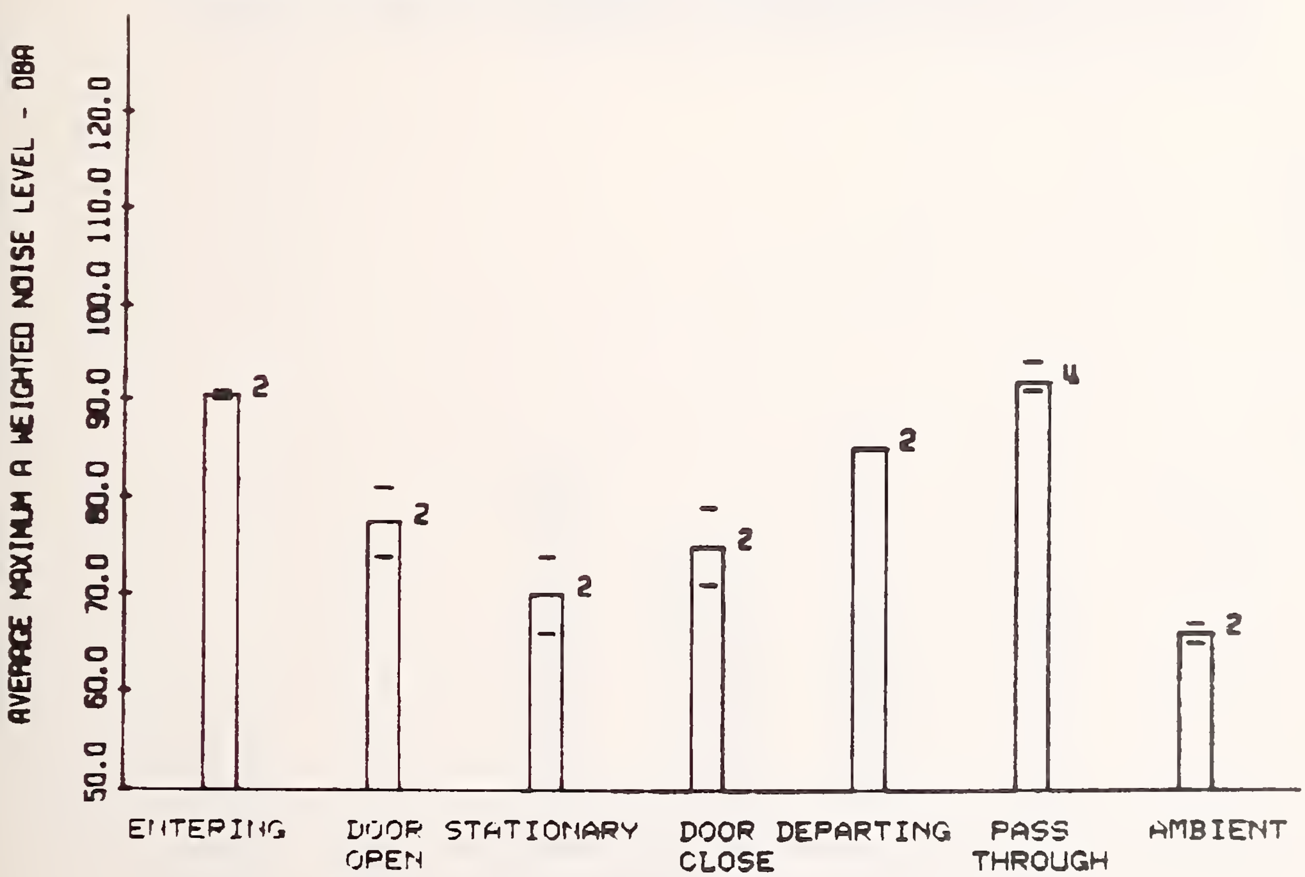
STATION-BELMONT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE   NO OF CARS: 2
STRUCTURE TYPE: ELEVATED STEEL   TRAIN TYPE: 6000
TRANSIT STATION TYPE: DUAL CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: A(B TRAINS PASS THROUGH)



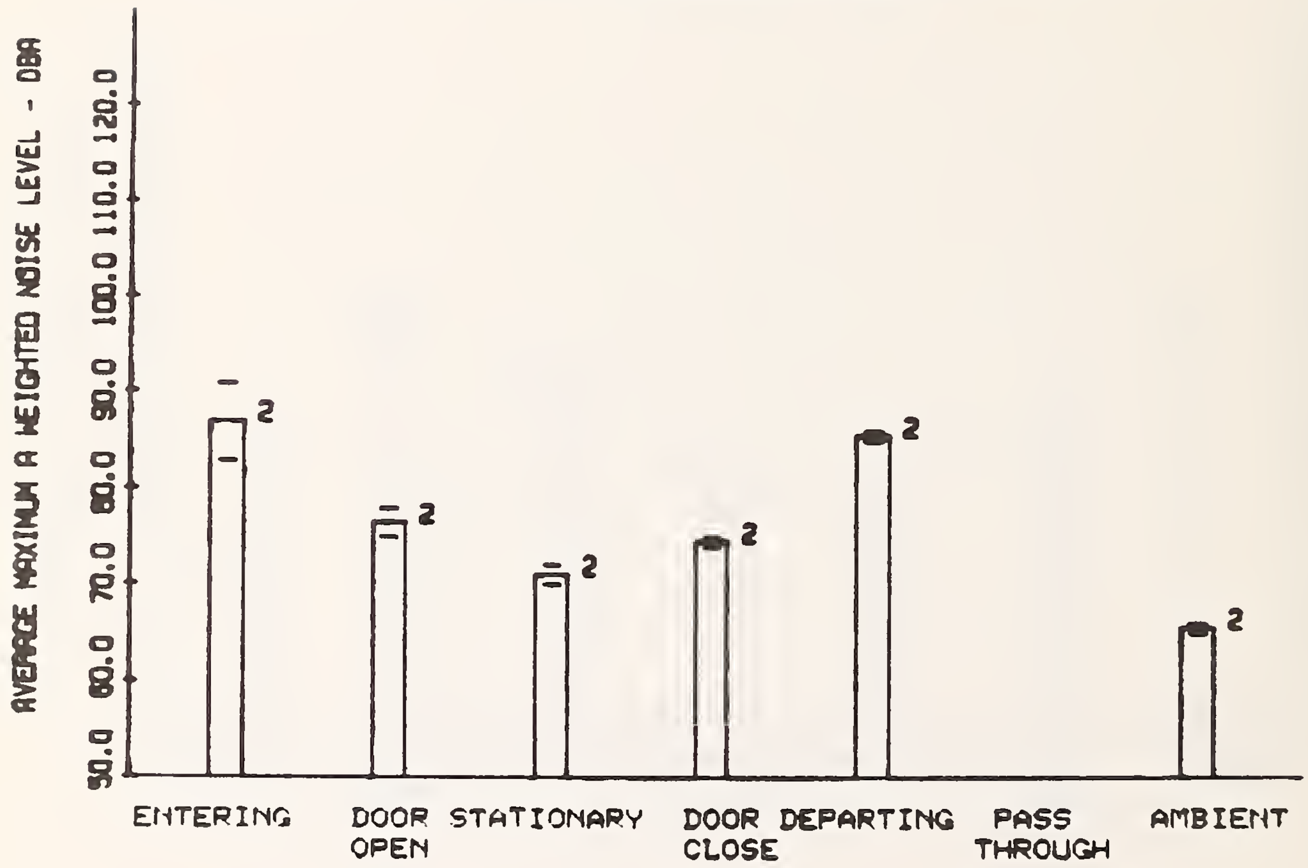
STATION-BELMONT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 4
STRUCTURE TYPE: ELEVATED STEEL TRAIN TYPE: 6000
TRANSIT STATION TYPE: DUAL CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: A(B TRAINS PASS THROUGH)



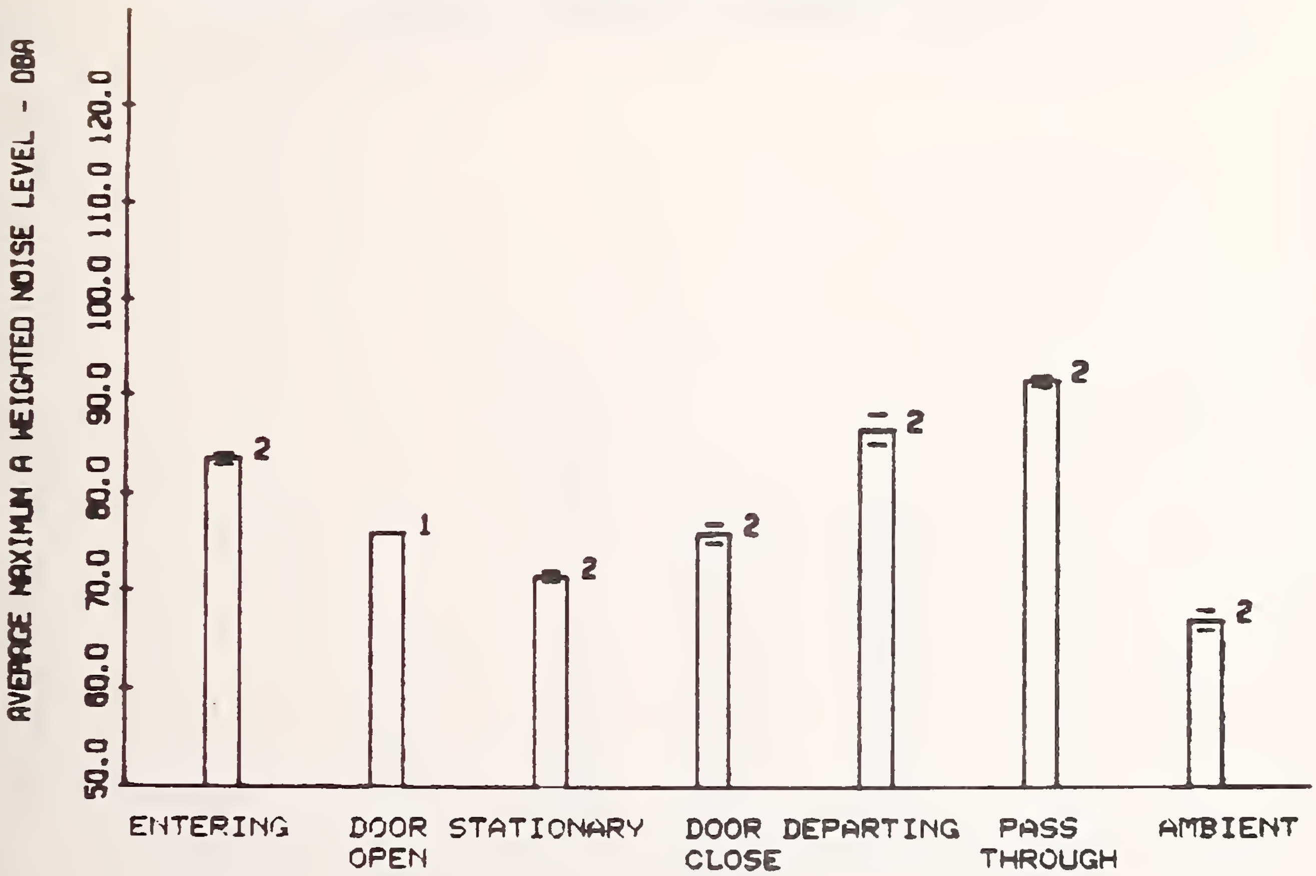
STATION-CERMAK
TRACK TYPE: BOLTED RAIL WITH WOOD TIE   NO OF CARS: 8
STRUCTURE TYPE: ELEVATED CONCRETE   TRAIN TYPE: 6000
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: ELEVATED CONCRETE, BALLAST
SERVICE TYPE: B(A TRAINS PASS THROUGH)



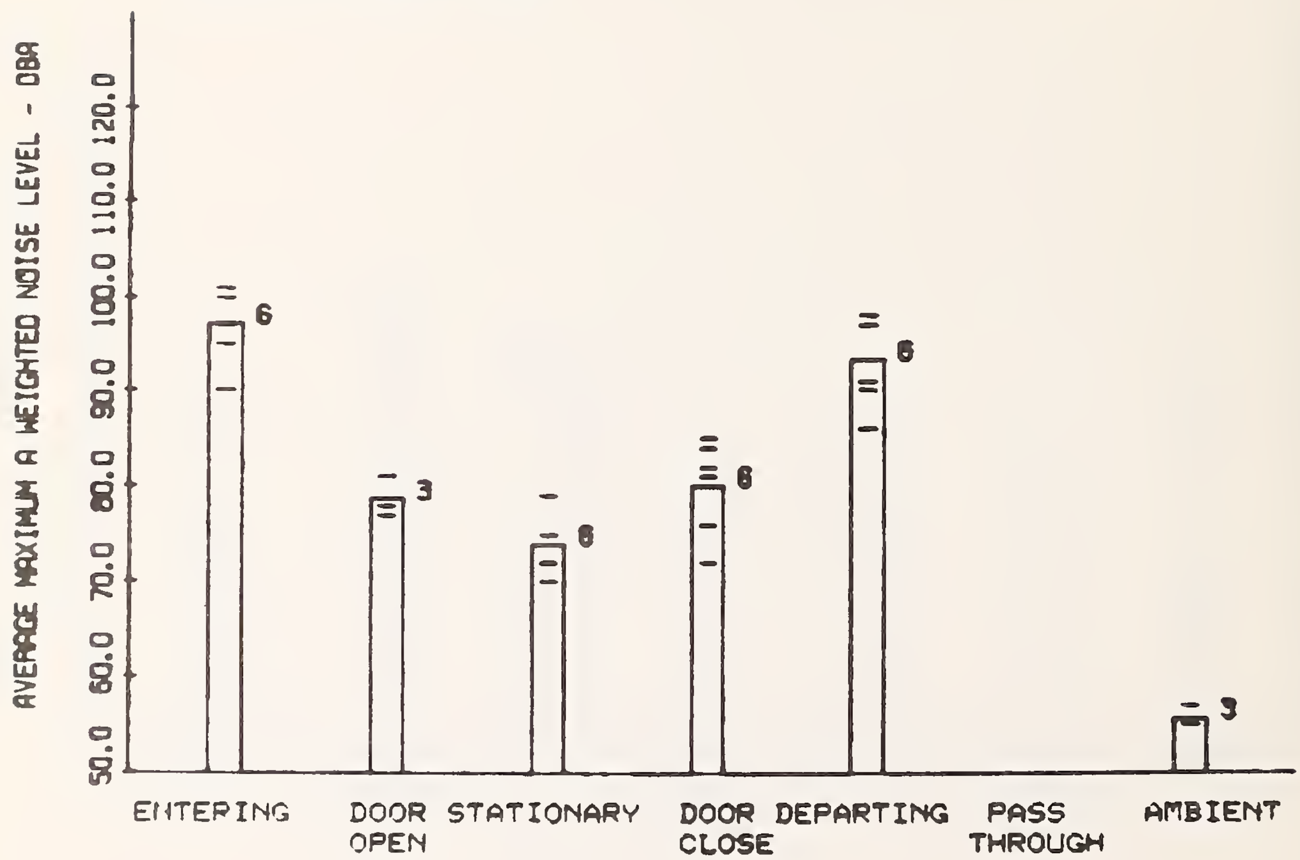
STATION-CERMAK
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 4
STRUCTURE TYPE: ELEVATED CONCRETE TRAIN TYPE: 2200
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: ELEVATED CONCRETE, BALLAST
SERVICE TYPE: B(A TRAINS PASS THROUGH)

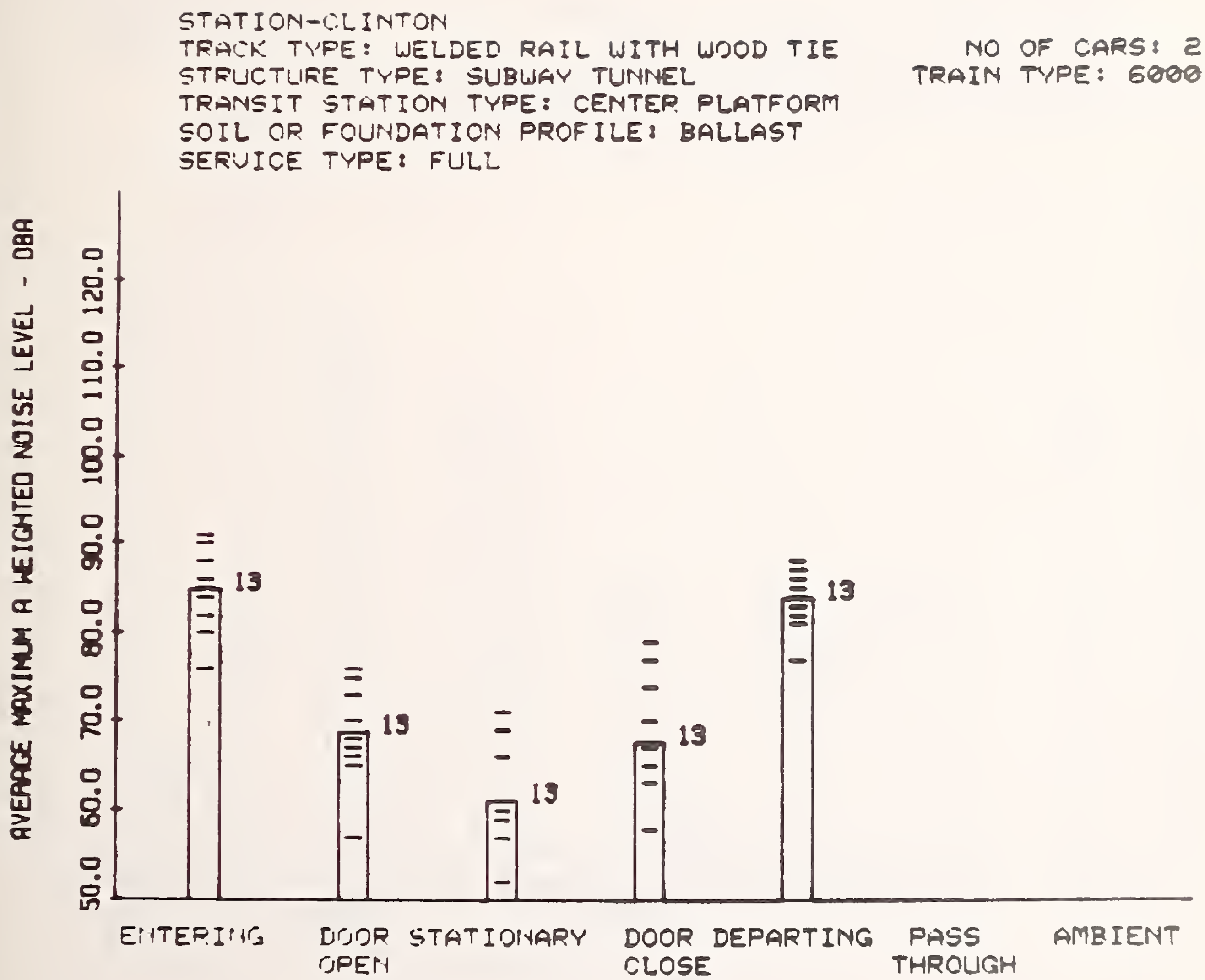


STATION-CERMAK
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 6
STRUCTURE TYPE: ELEVATED CONCRETE TRAIN TYPE: 6000
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: ELEVATED CONCRETE, BALLAST
SERVICE TYPE: B(A TRAINS PASS THROUGH)

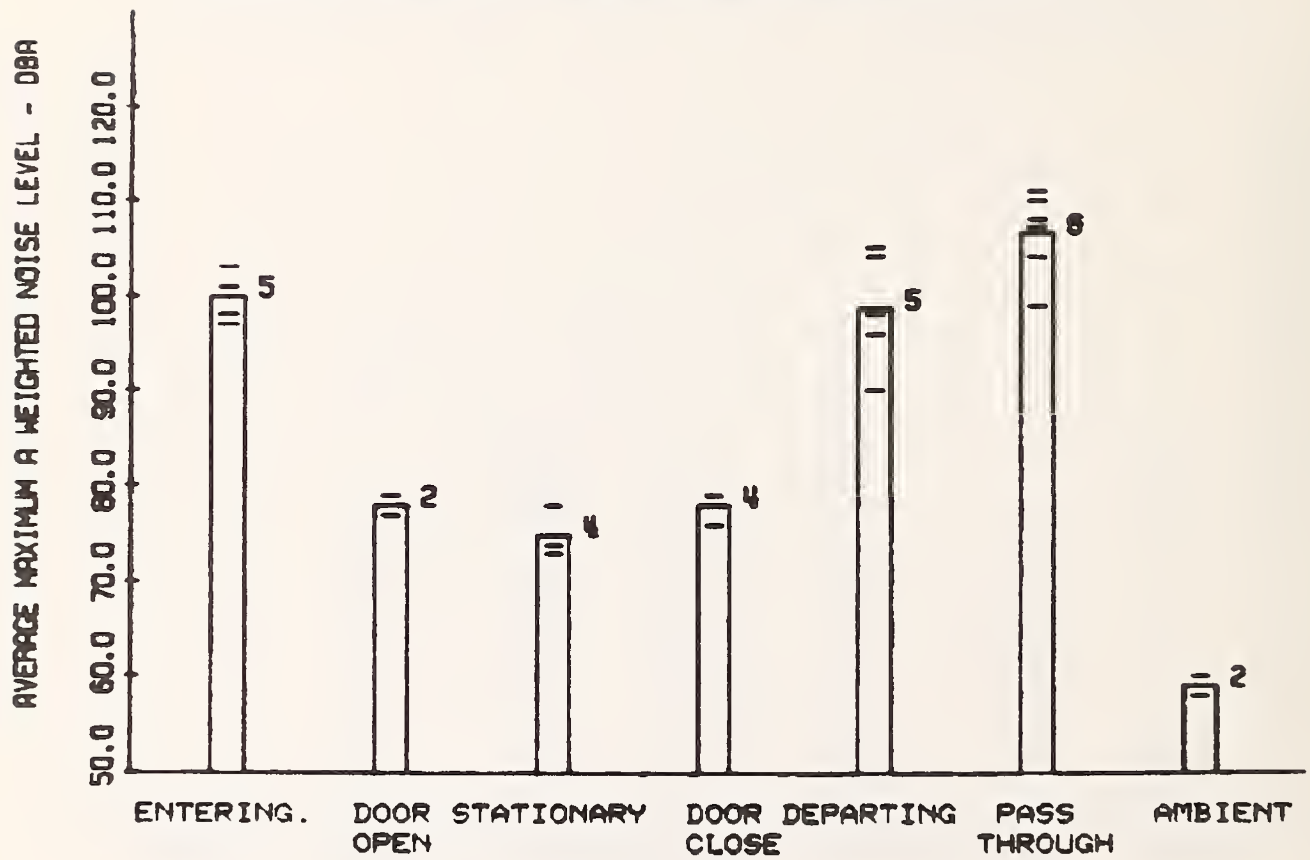


STATION-CHICAGO
TRACK TYPE: WELDED RAIL WITH WOOD TIE NO OF CARS: 4
STRUCTURE TYPE: SUBWAY TUNNEL TRAIN TYPE: 6000
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: FULL



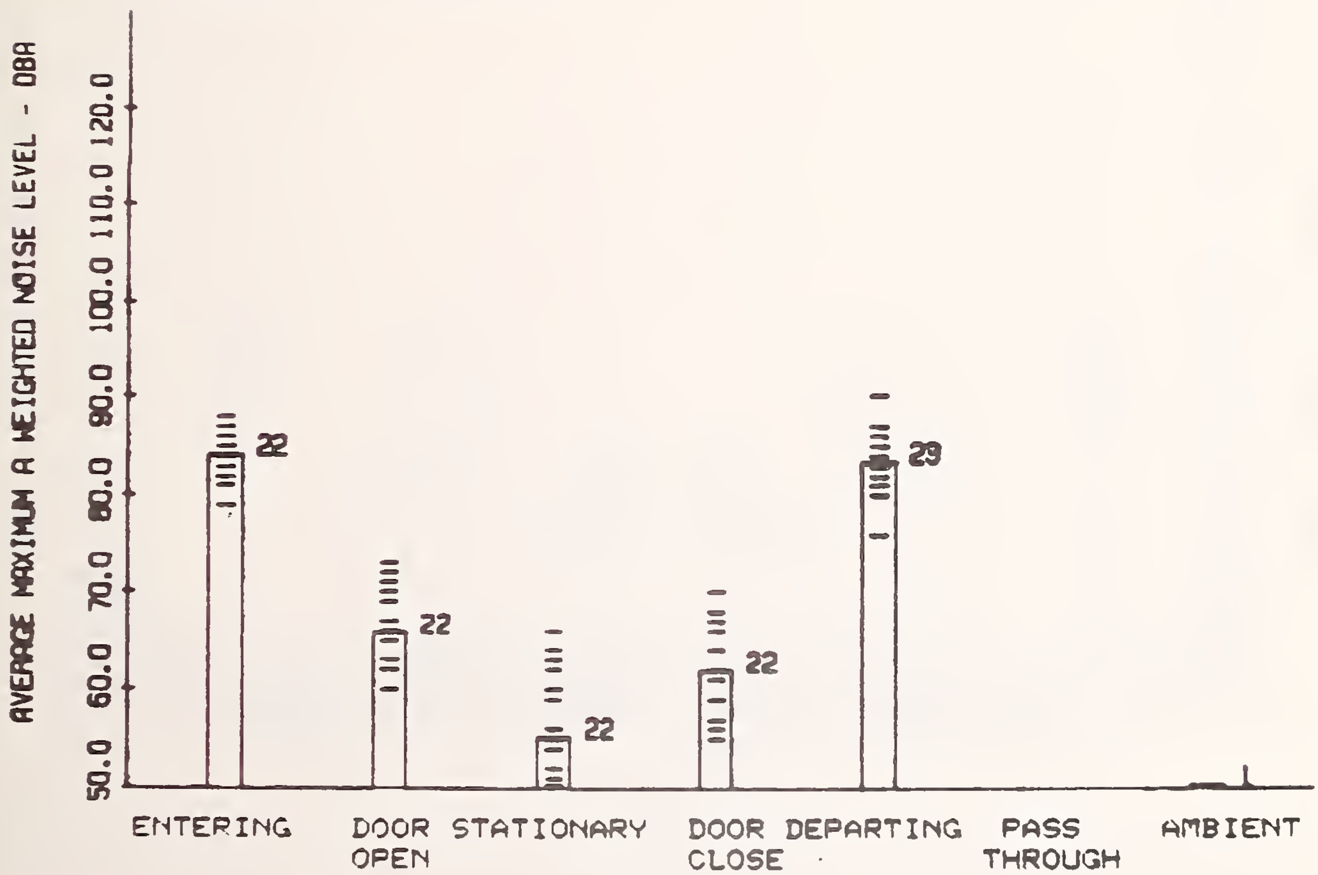

STATION-CLINTON
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL
NO OF CARS: 2
TRAIN TYPE: 6000
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
13
13
13
13
13
ENTERING
DOOR OPEN
STATIONARY
DOOR CLOSE
DEPARTING
PASS THROUGH
AMBIENT

STATION-CLARK
TRACK TYPE: WELDED RAIL WITH WOOD TIE — NO OF CARS: 4
STRUCTURE TYPE: SUBWAY TUNNEL — TRAIN TYPE: 6000
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: A(B TRAINS PASS THROUGH)



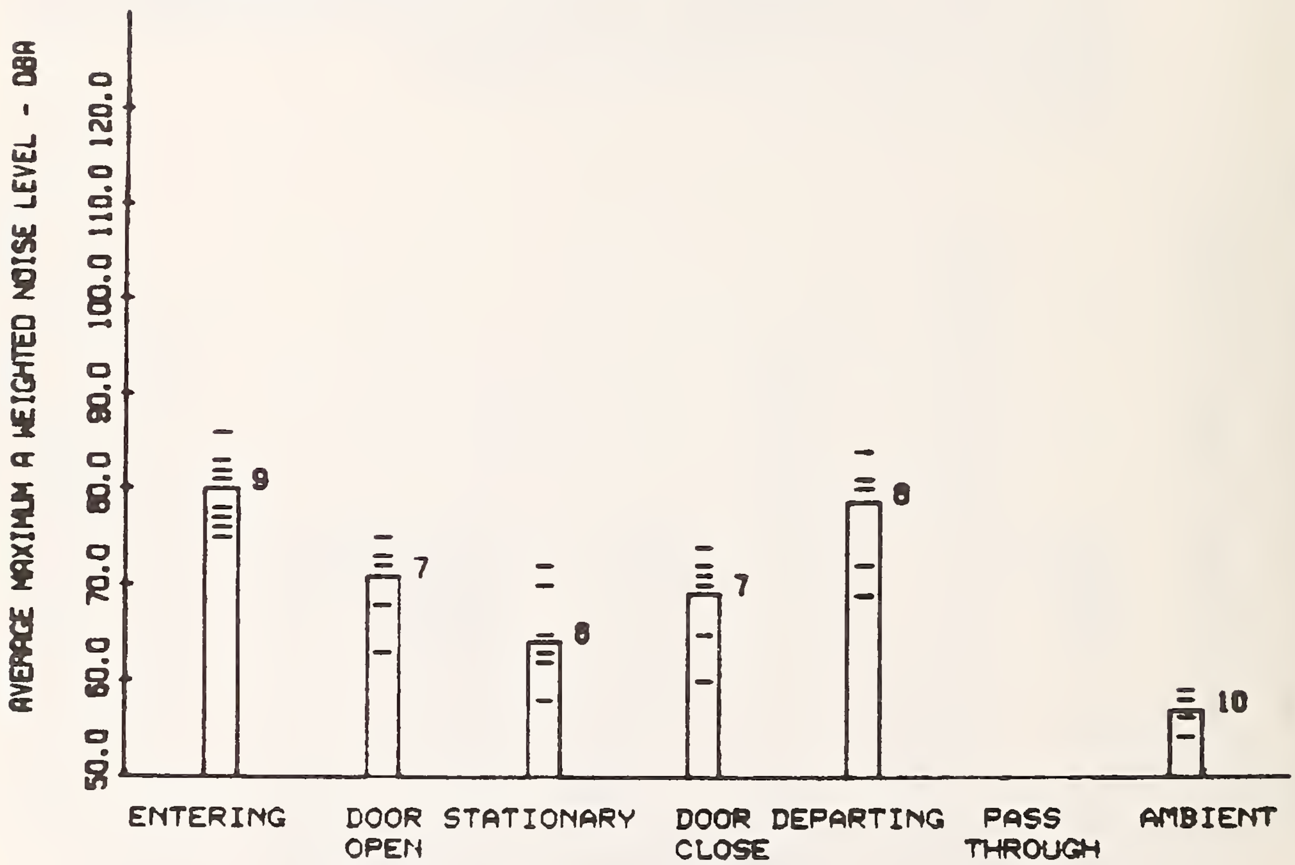
STATION-CLINTON
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

NO OF CARS: 2
TRAIN TYPE: 2200



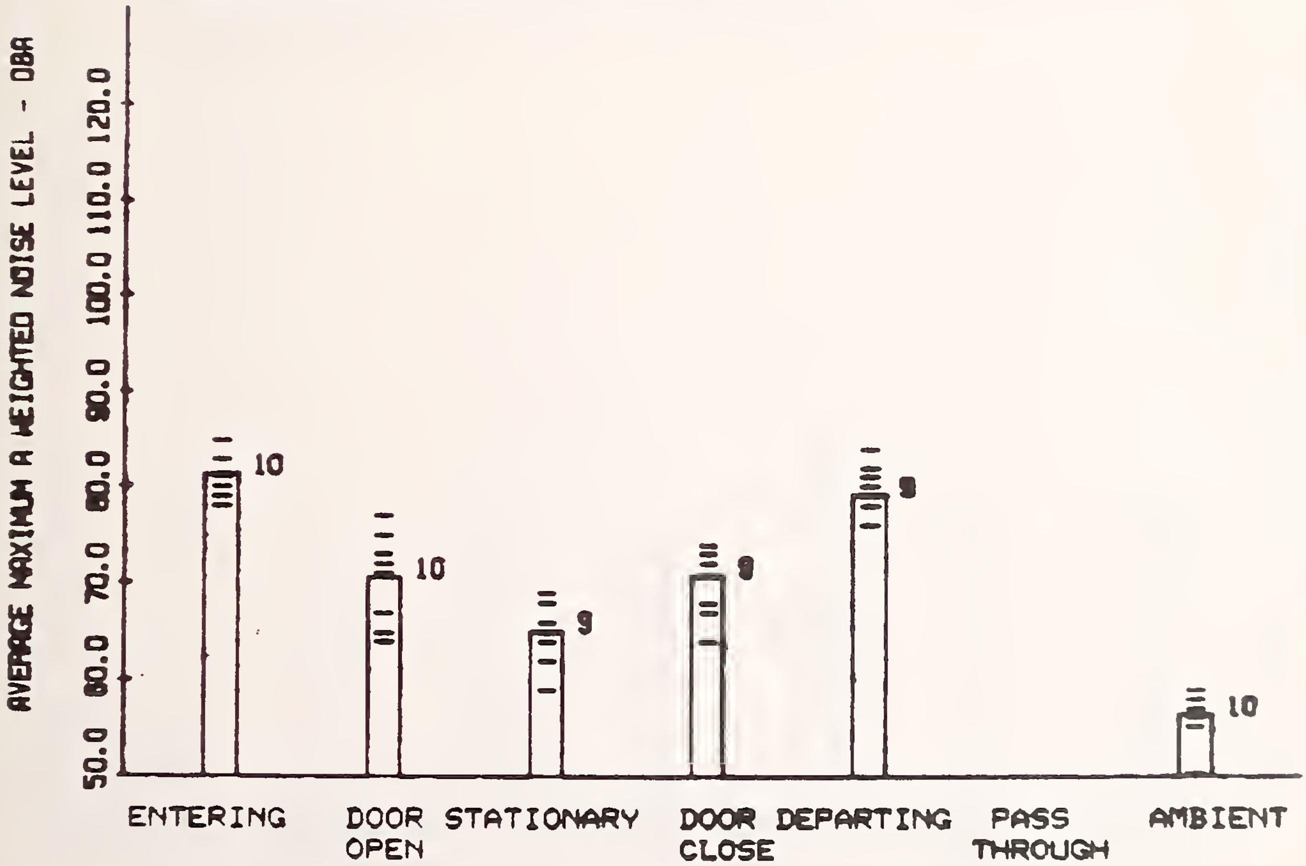
STATION-DAVIS
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

NO OF CARS: 1
TRAIN TYPE: 6000



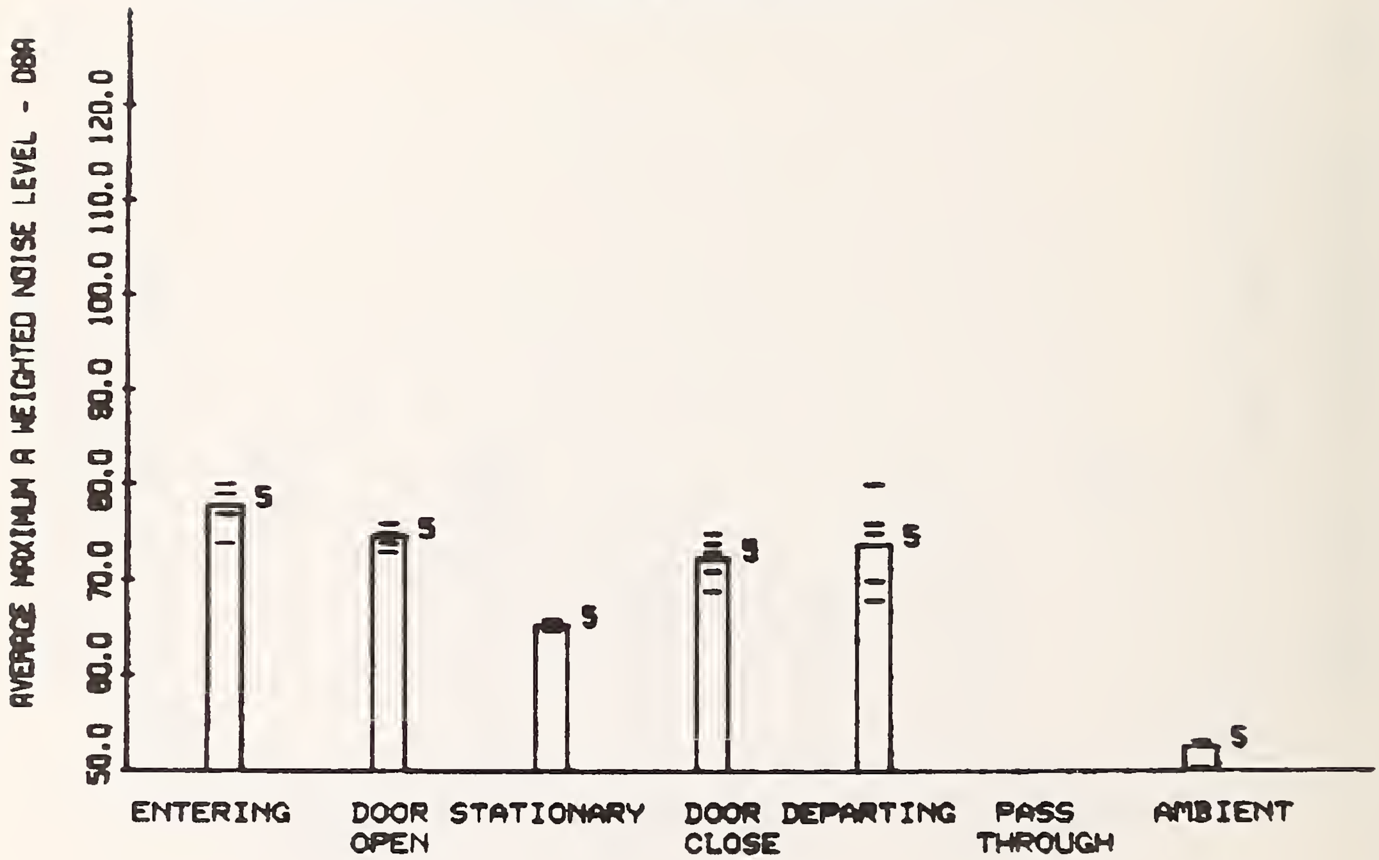
STATION-FOSTER
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: A(B TRAINS PASS THROUGH)

NO OF CARS: 1
TRAIN TYPE: 6000

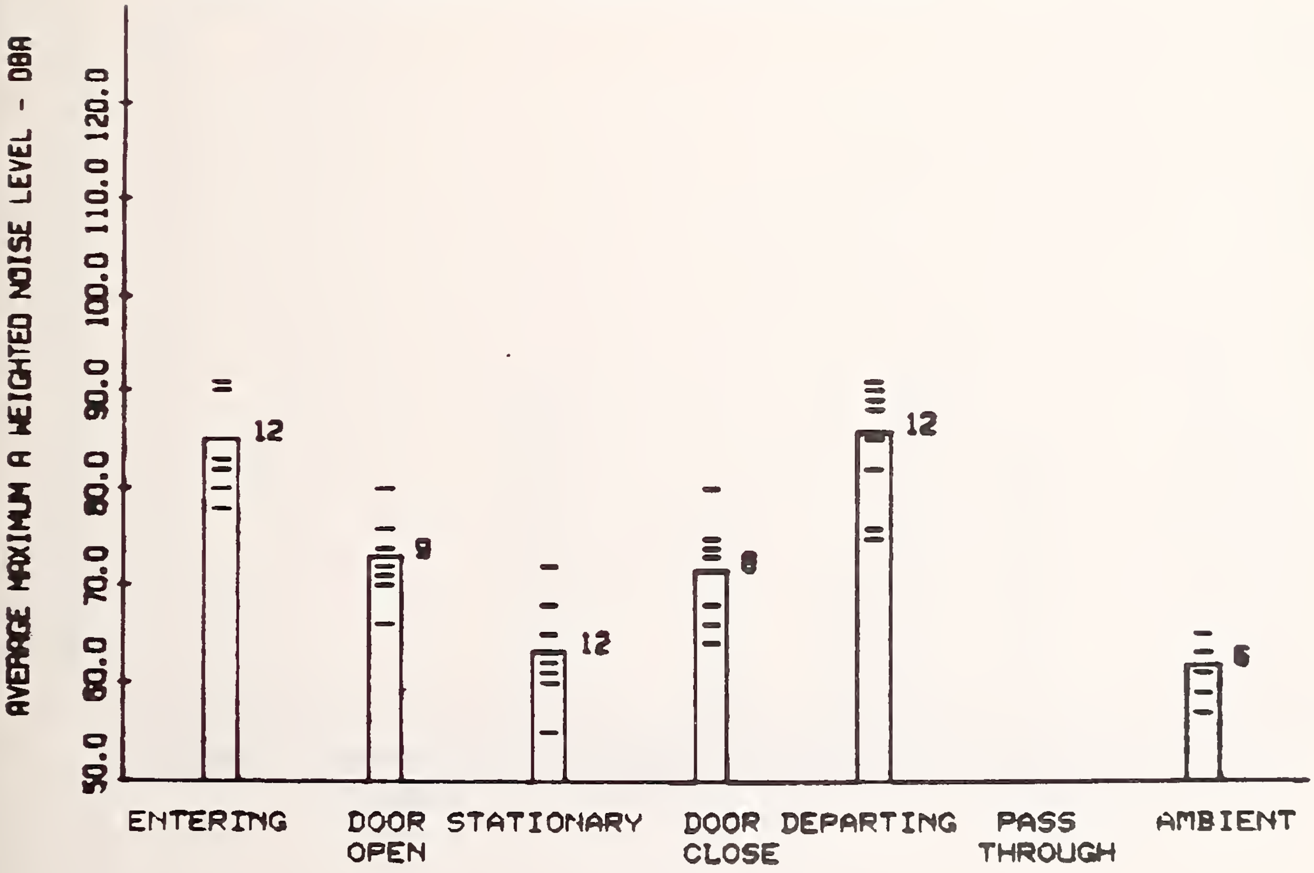


STATION-FRANCISCO
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: AT-GRADE
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: A(B TRAINS PASS THROUGH)

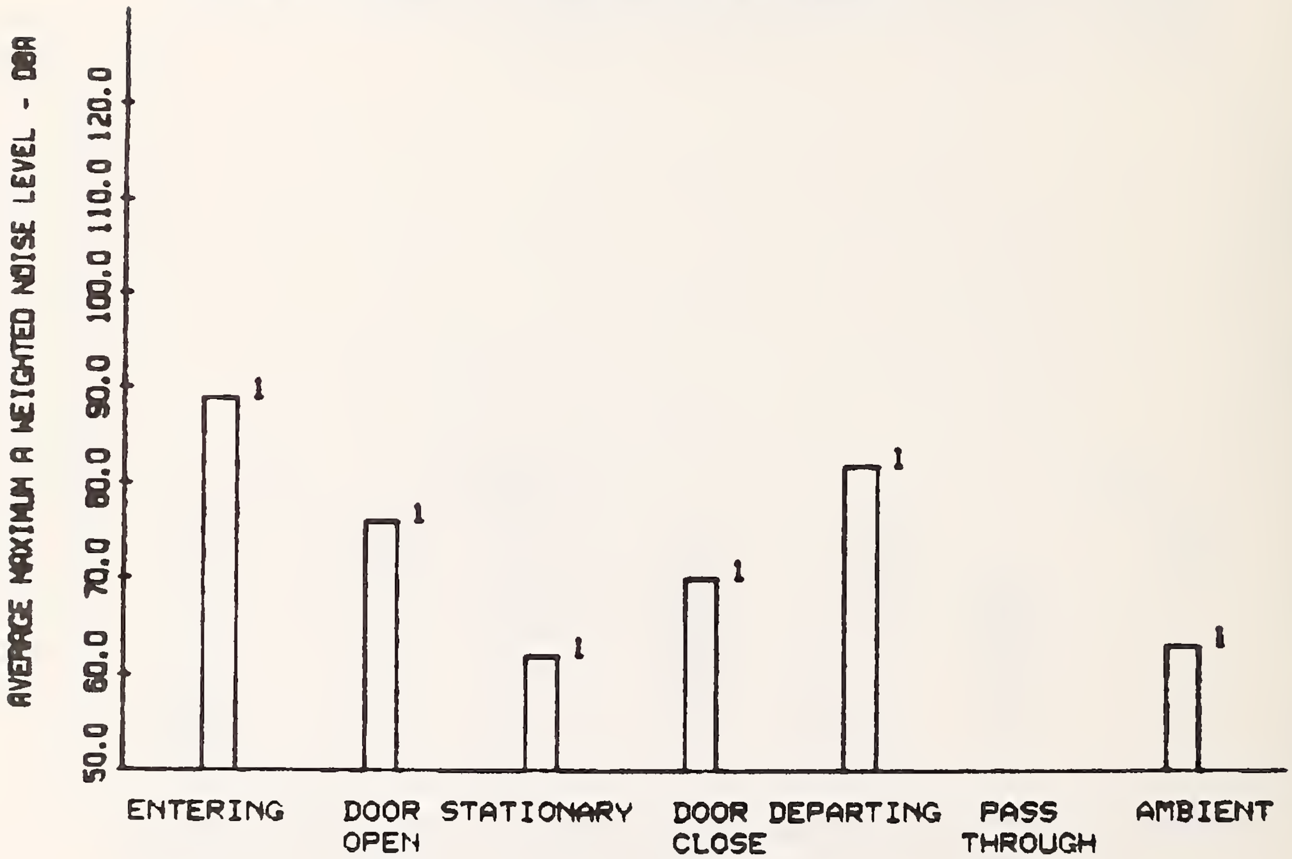
NO OF CARS: 2
TRAIN TYPE: 6000



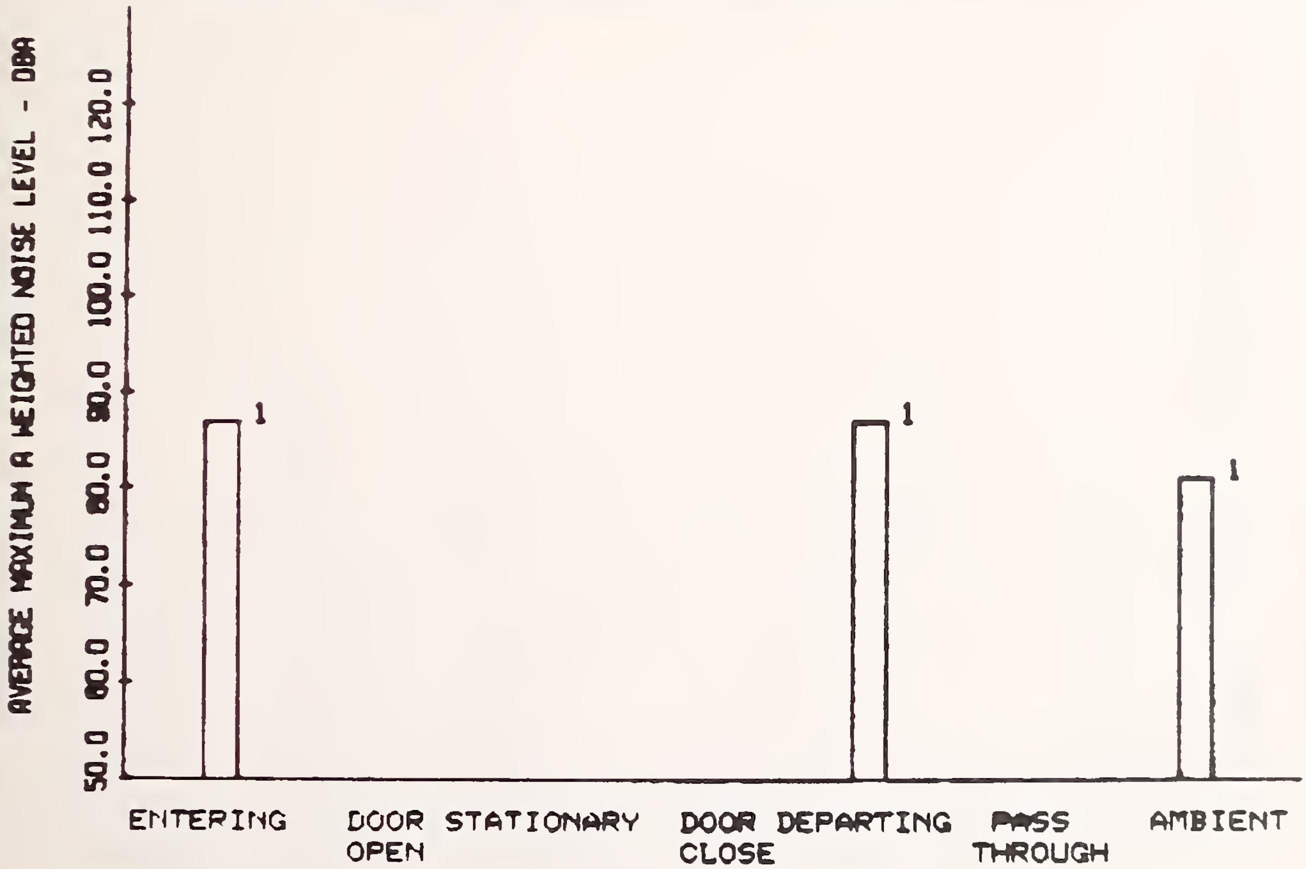
STATION-HOYNE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 2
STRUCTURE TYPE: ELEVATED STEEL TRAIN TYPE: 2200
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: B(A TRAINS PASS THROUGH)

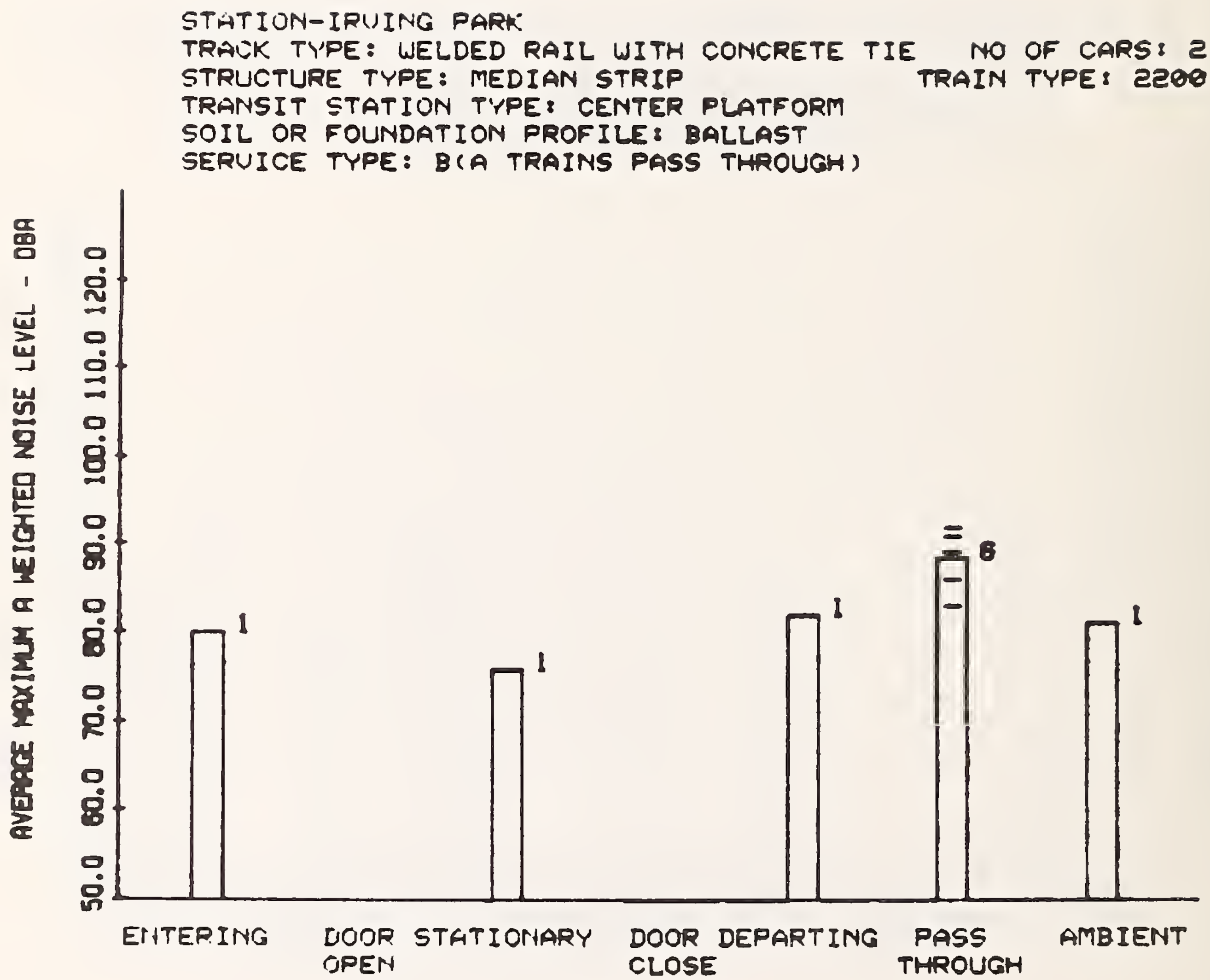


STATION-HOYNE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 2
STRUCTURE TYPE: ELEVATED STEEL TRAIN TYPE: 6000
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: B(A TRAINS PASS THROUGH)



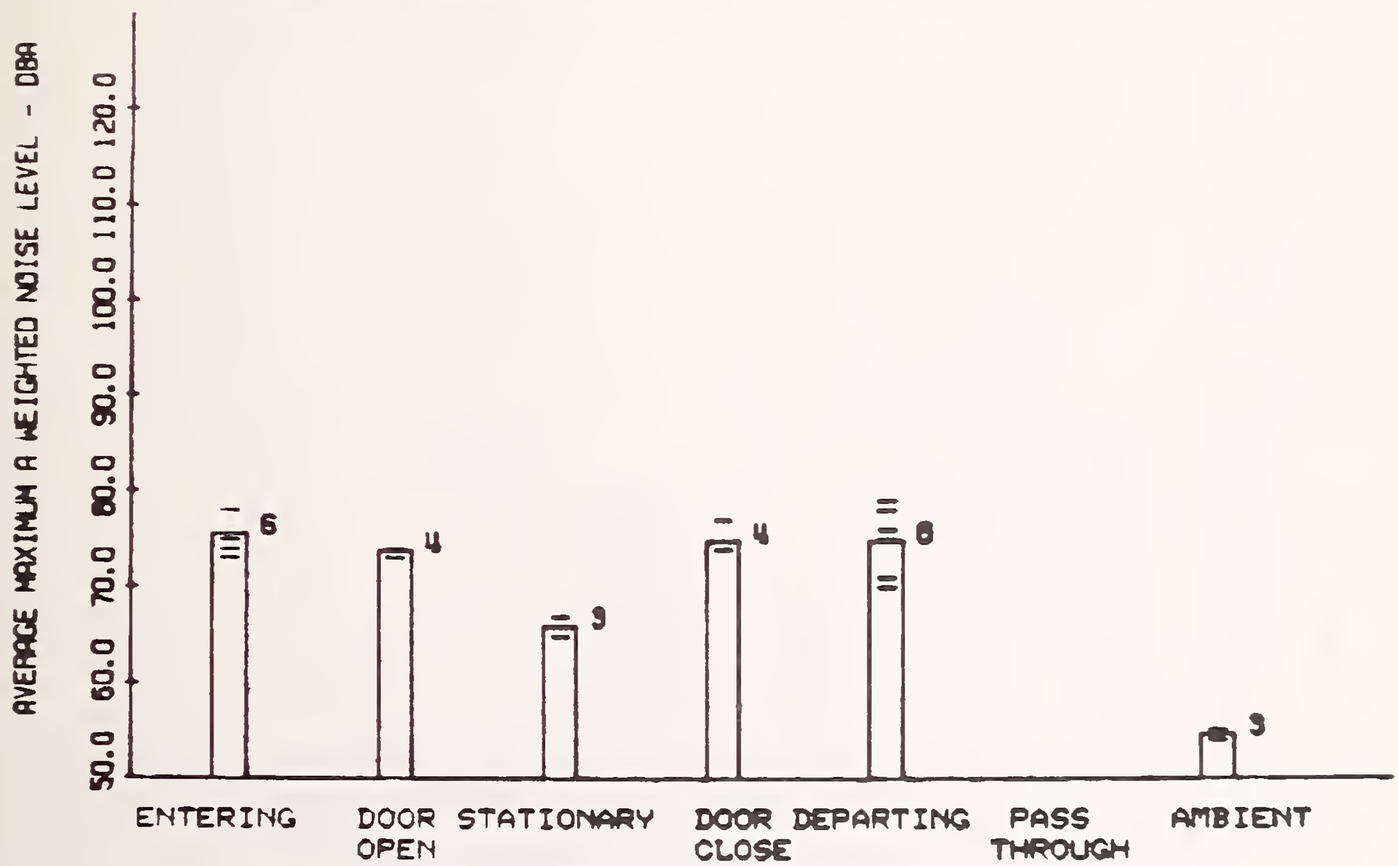
STATION-IRVING PARK
TRACK TYPE: WELDED RAIL WITH CONCRETE TIE   NO OF CARS: 2
STRUCTURE TYPE: MEDIAN STRIP   TRAIN TYPE: 6000
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: B(A TRAINS PASS THROUGH)




STATION-IRVING PARK
TRACK TYPE: WELDED RAIL WITH CONCRETE TIE
NO OF CARS: 2
STRUCTURE TYPE: MEDIAN STRIP
TRAIN TYPE: 2200
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: B(A TRAINS PASS THROUGH)
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
1
1
1
6
1
ENTERING
DOOR OPEN
STATIONARY
DOOR CLOSE
DEPARTING
PASS THROUGH
AMBIENT

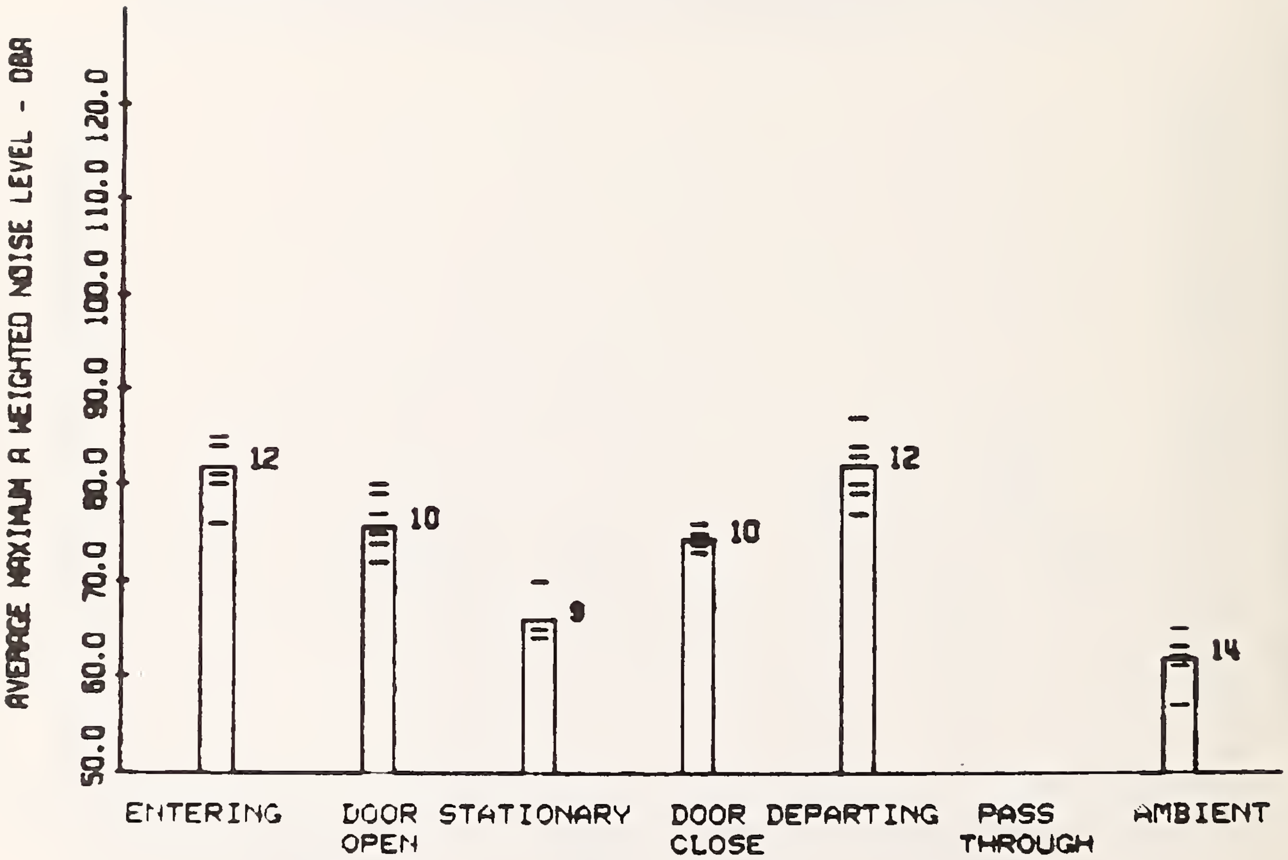
STATION-KEDZIE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: AT-GRADE
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

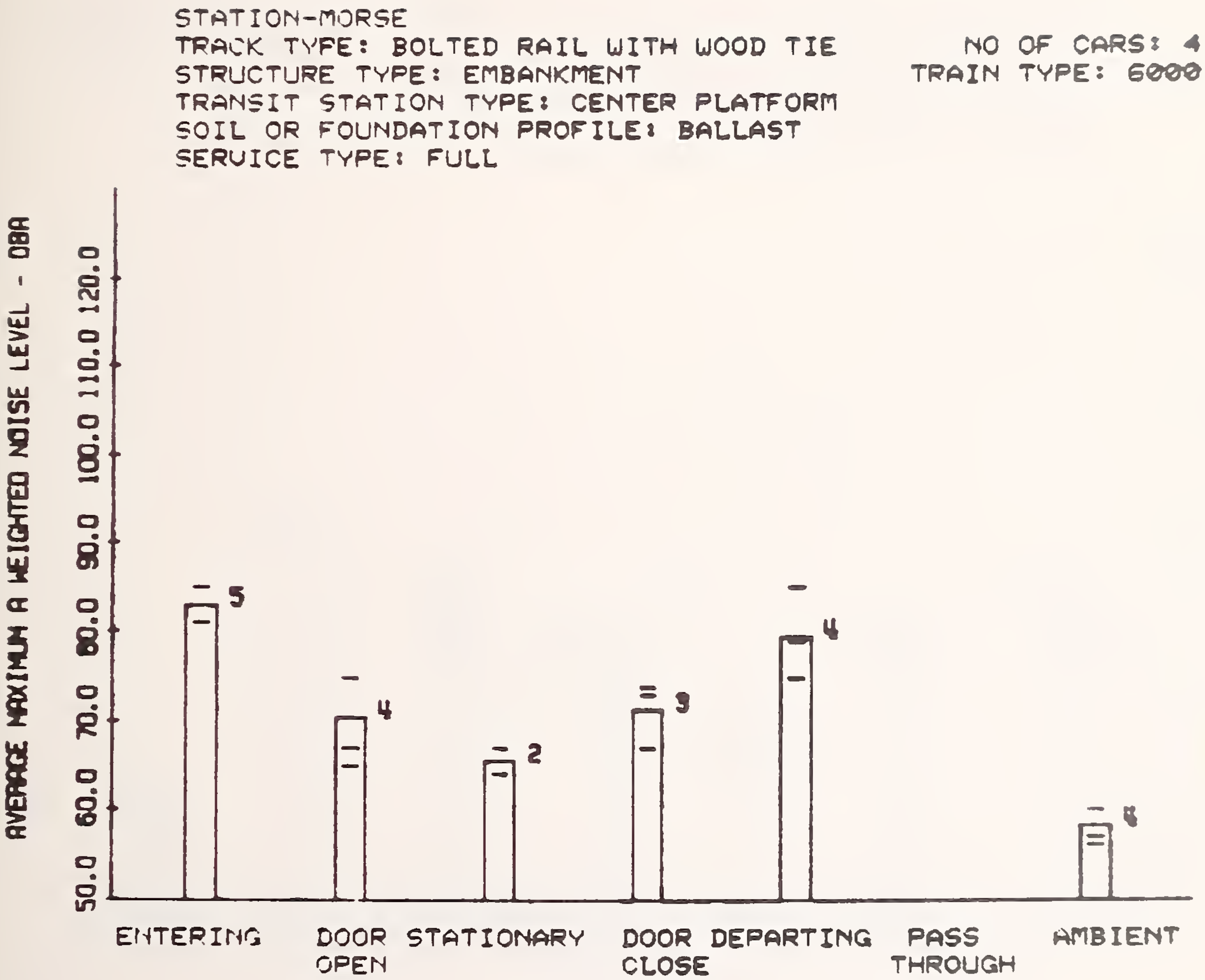
NO OF CARS: 2
TRAIN TYPE: 6000



STATION-LOYOLA
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

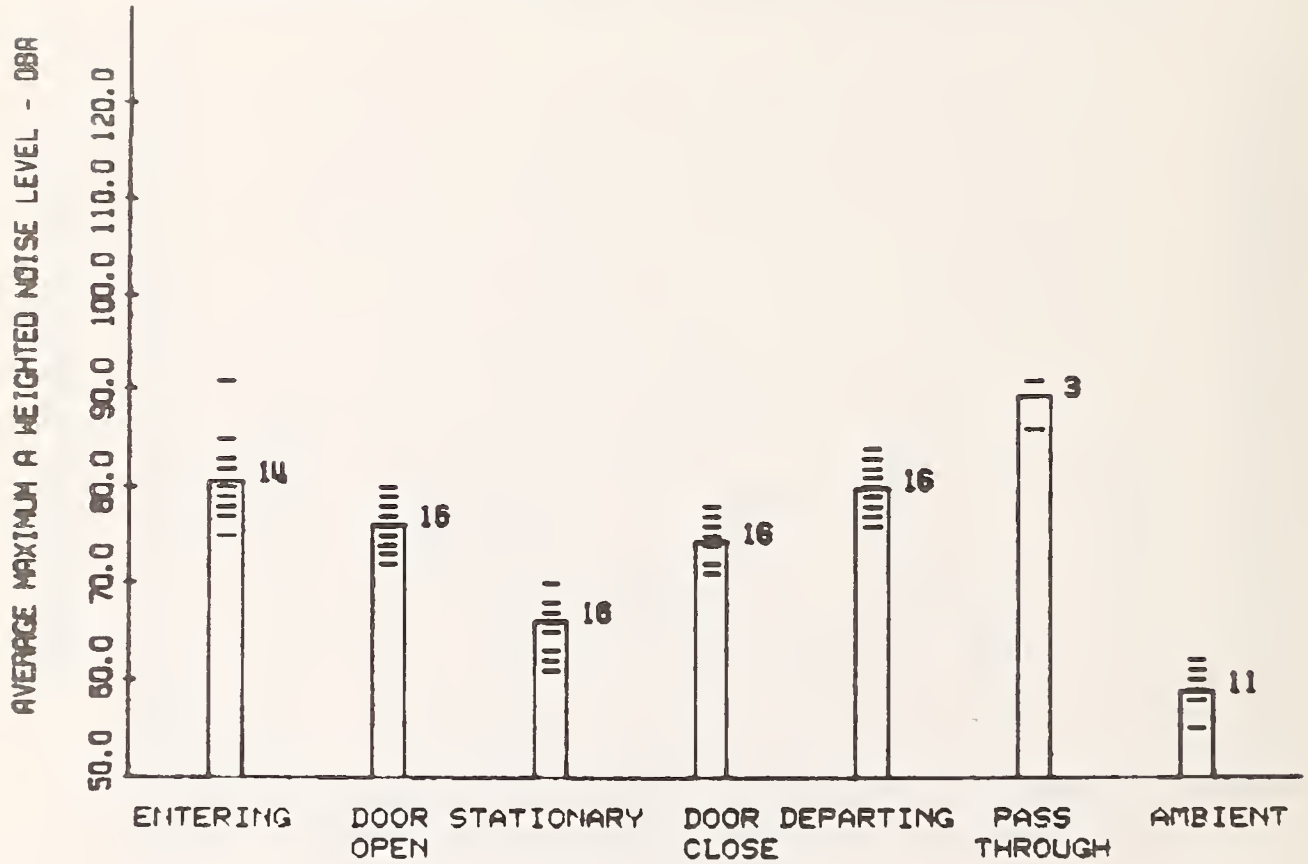
NO OF CARS: 4
TRAIN TYPE: 6000




STATION-MORSE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL
NO OF CARS: 4
TRAIN TYPE: 6000
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
5
4
2
3
4
ENTERING
DOOR OPEN
STATIONARY
DOOR CLOSE
DEPARTING
PASS THROUGH
AMBIENT

STATION-MORSE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

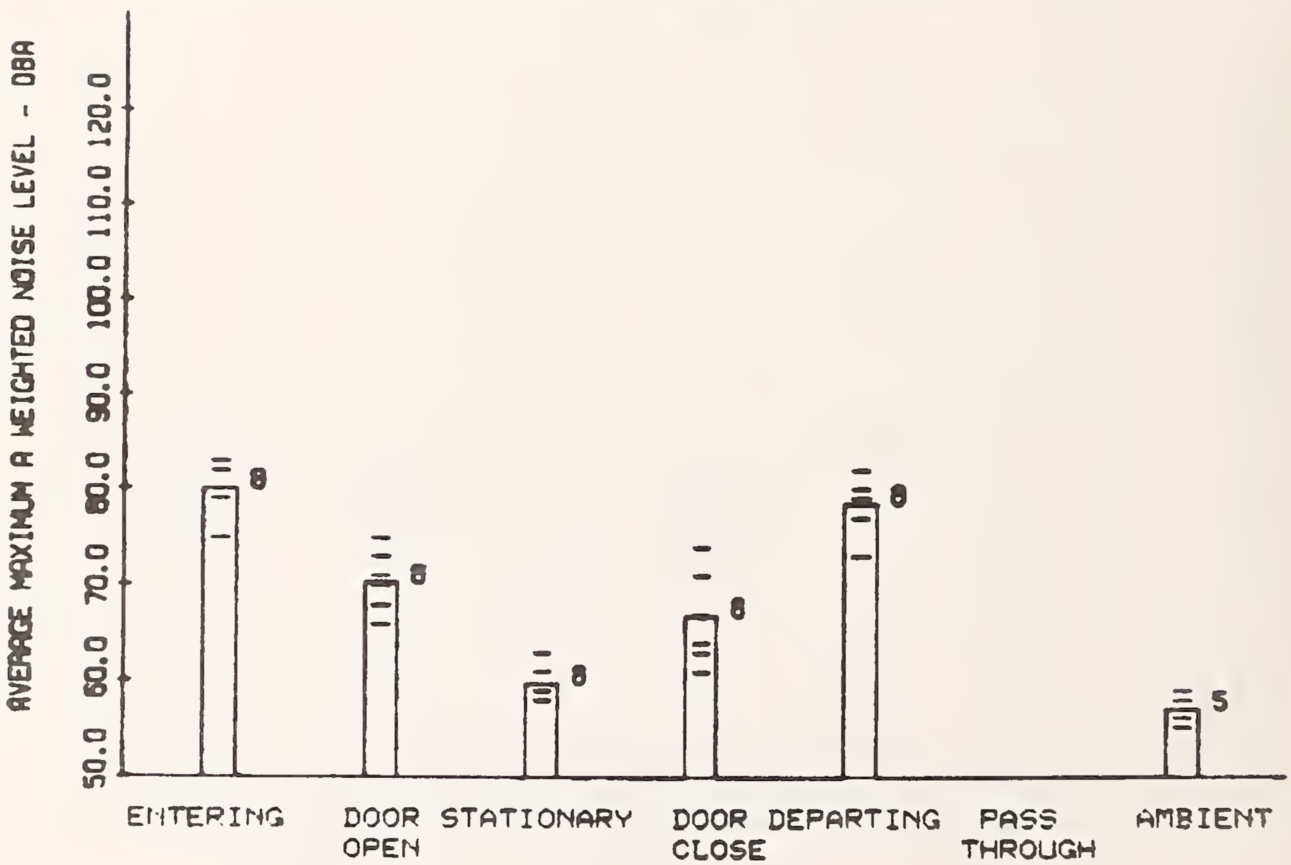
NO OF CARS: 4
TRAIN TYPE: 6000



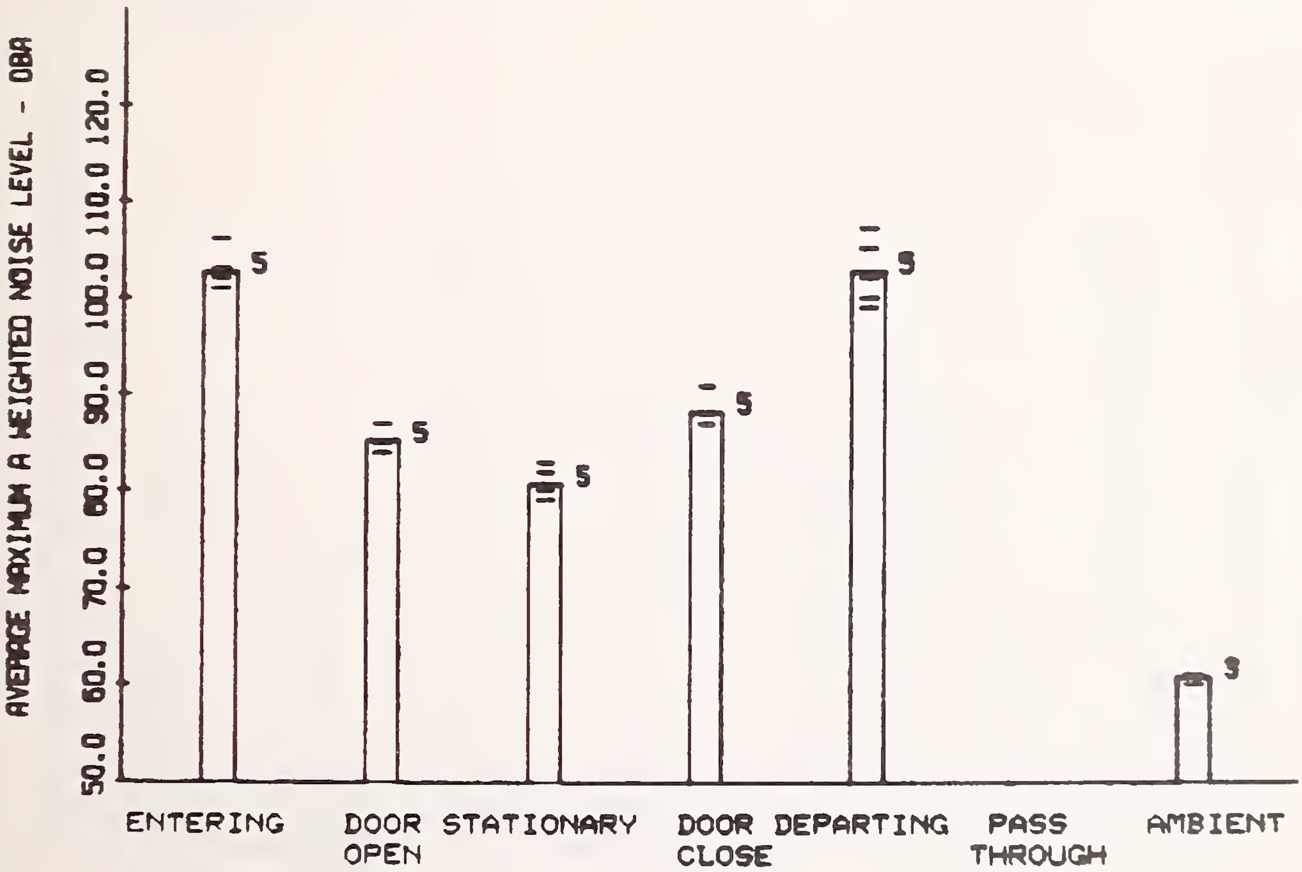
STATION-OAK PARK
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: AT-GRADE
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: A(B TRAINS PASS THROUGH)

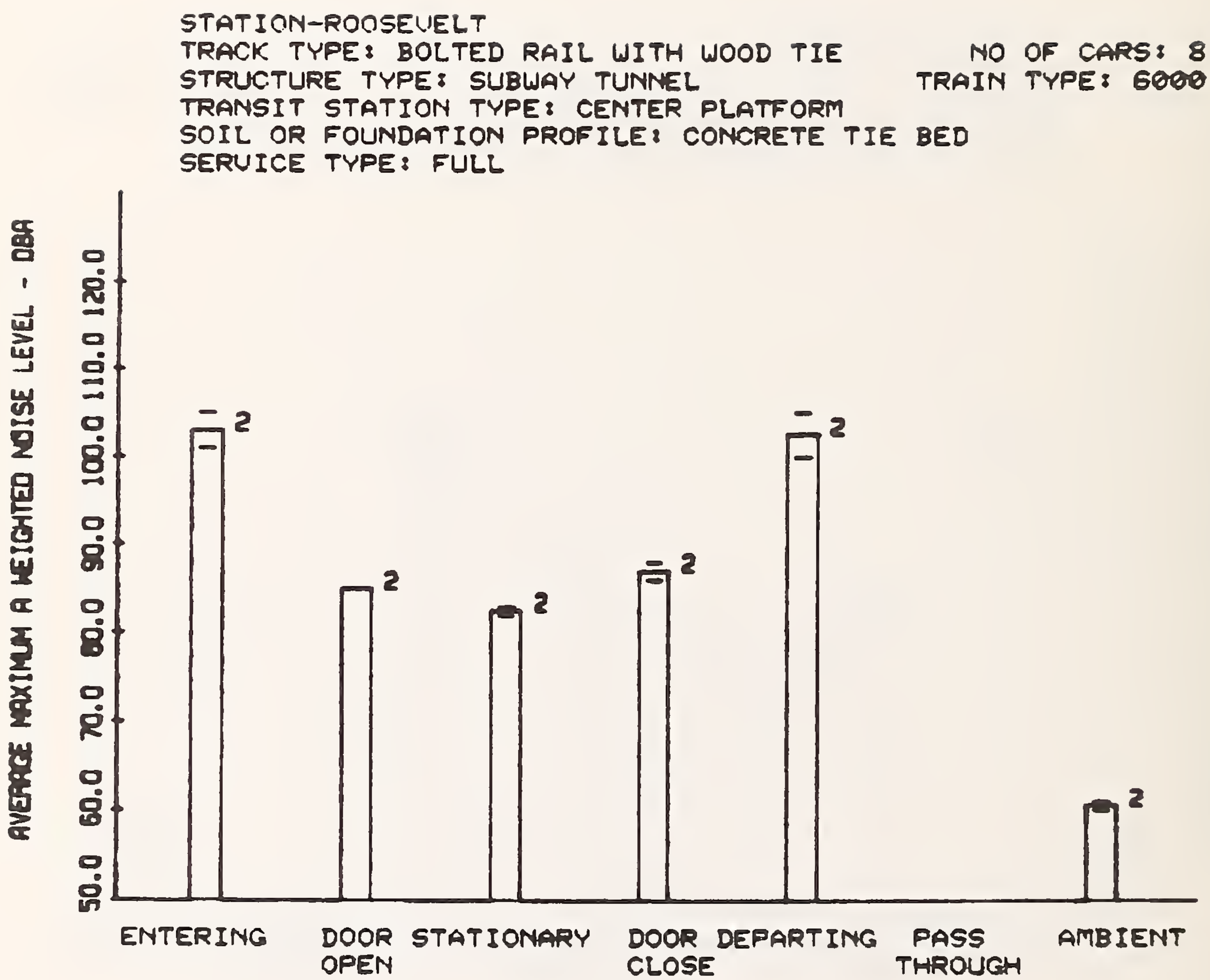
NO OF CARS: 2
TRAIN TYPE: 6000

STATION-PULASKI
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 2
STRUCTURE TYPE: ELEVATED STEEL TRAIN TYPE: 2200
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: B(A TRAINS PASS THROUGH)

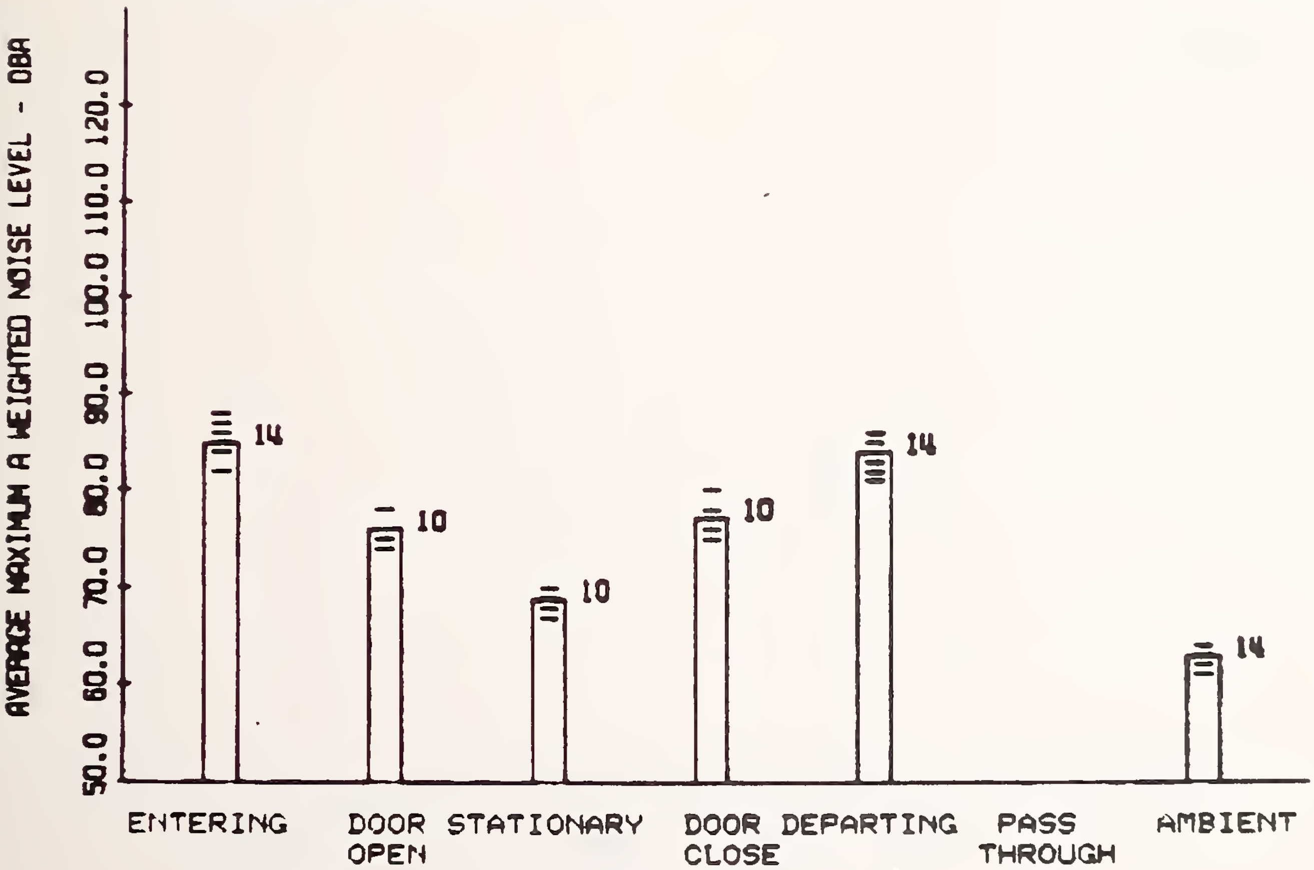


STATION-ROOSEVELT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 4
STRUCTURE TYPE: SUBWAY TUNNEL TRAIN TYPE: 6000
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: FULL



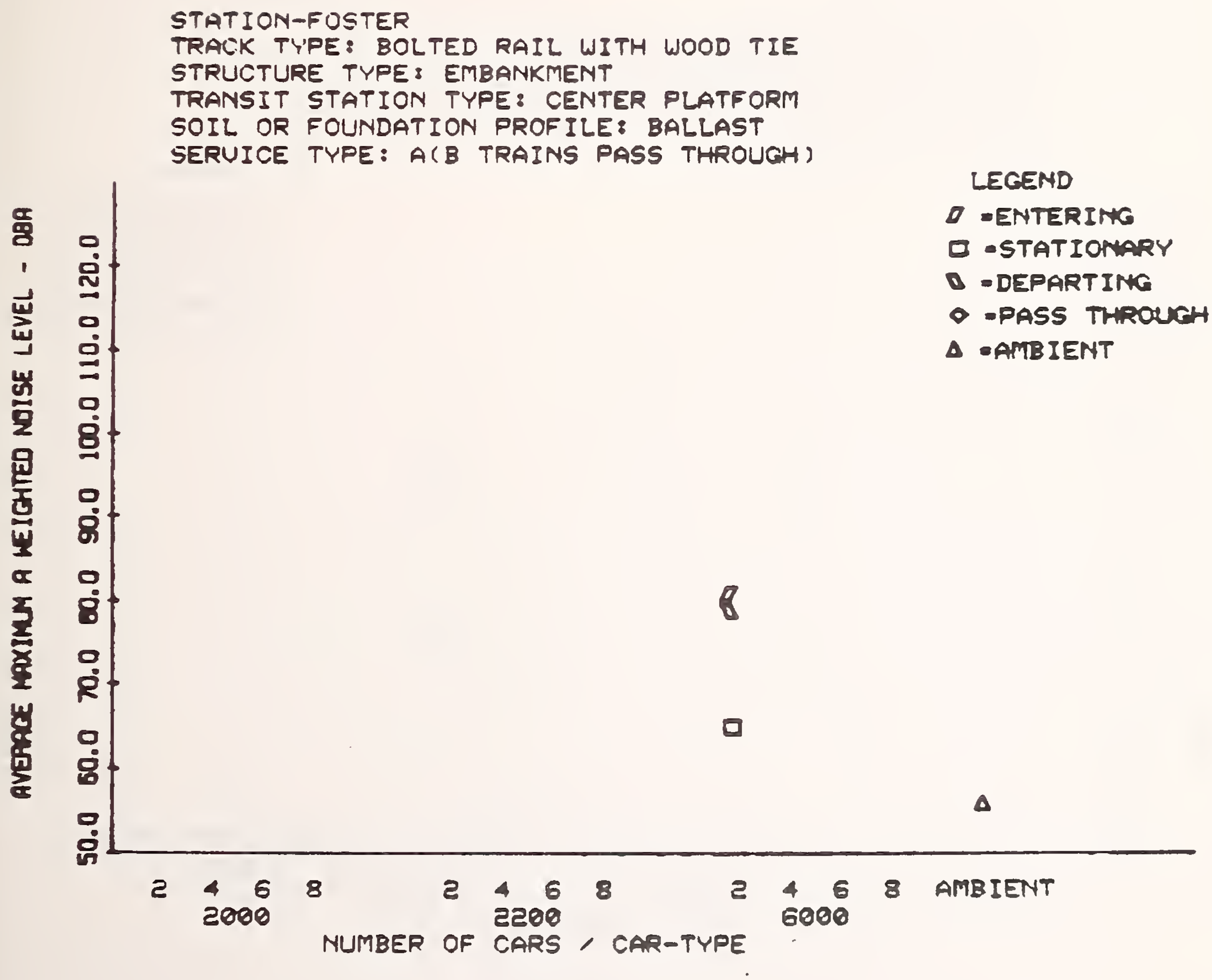

STATION-ROOSEVELT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NO OF CARS: 8
STRUCTURE TYPE: SUBWAY TUNNEL
TRAIN TYPE: 6000
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: FULL
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2
2
2
2
2
2
ENTERING
DOOR OPEN
STATIONARY
DOOR CLOSE
DEPARTING
PASS THROUGH
AMBIENT

STATION-WILSON
TRACK TYPE: BOLTED RAIL WITH WOOD TIE NO OF CARS: 4
STRUCTURE TYPE: ELEVATED STEEL TRAIN TYPE: 6000
TRANSIT STATION TYPE: TRIPLE CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: FULL

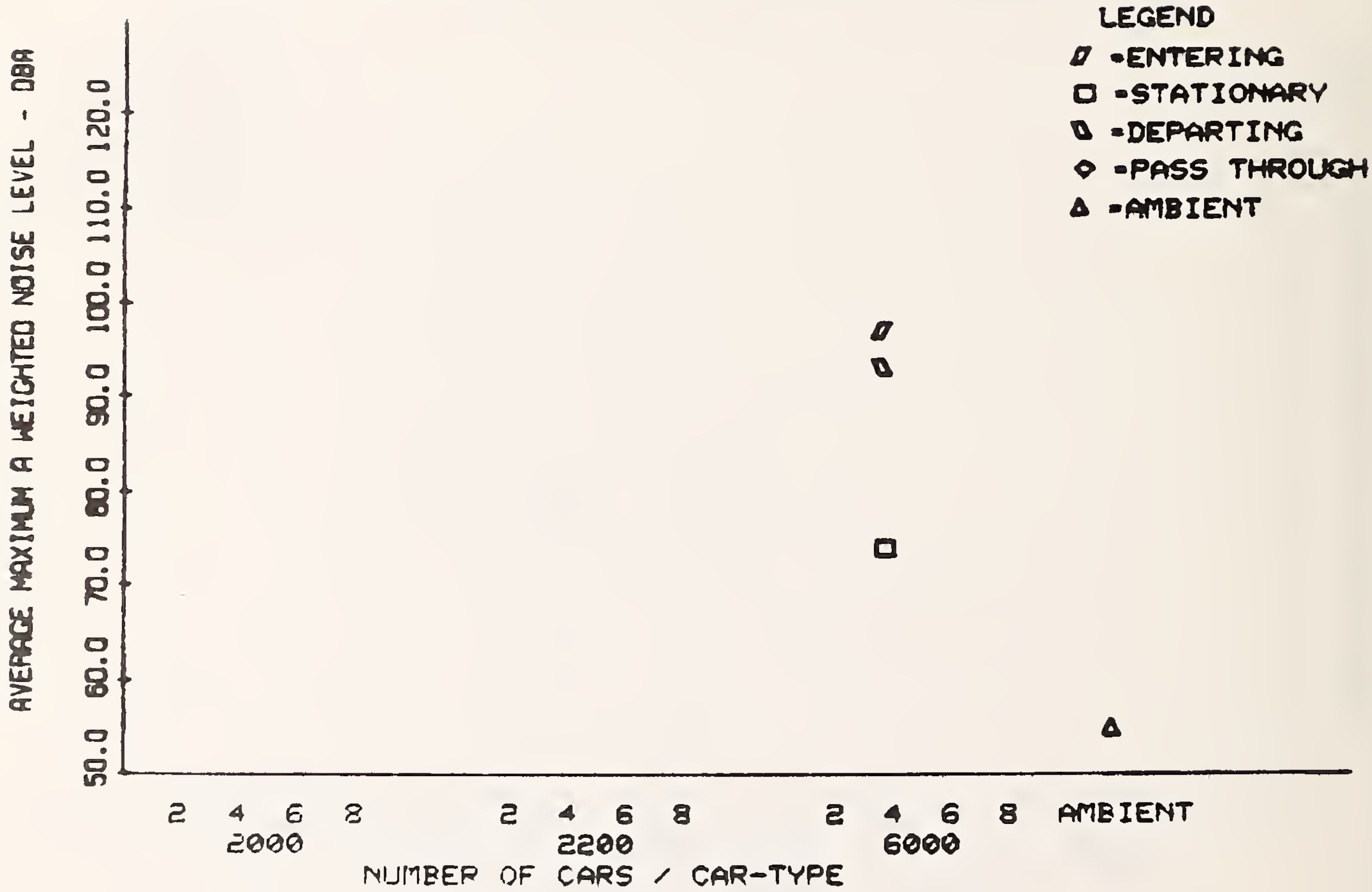


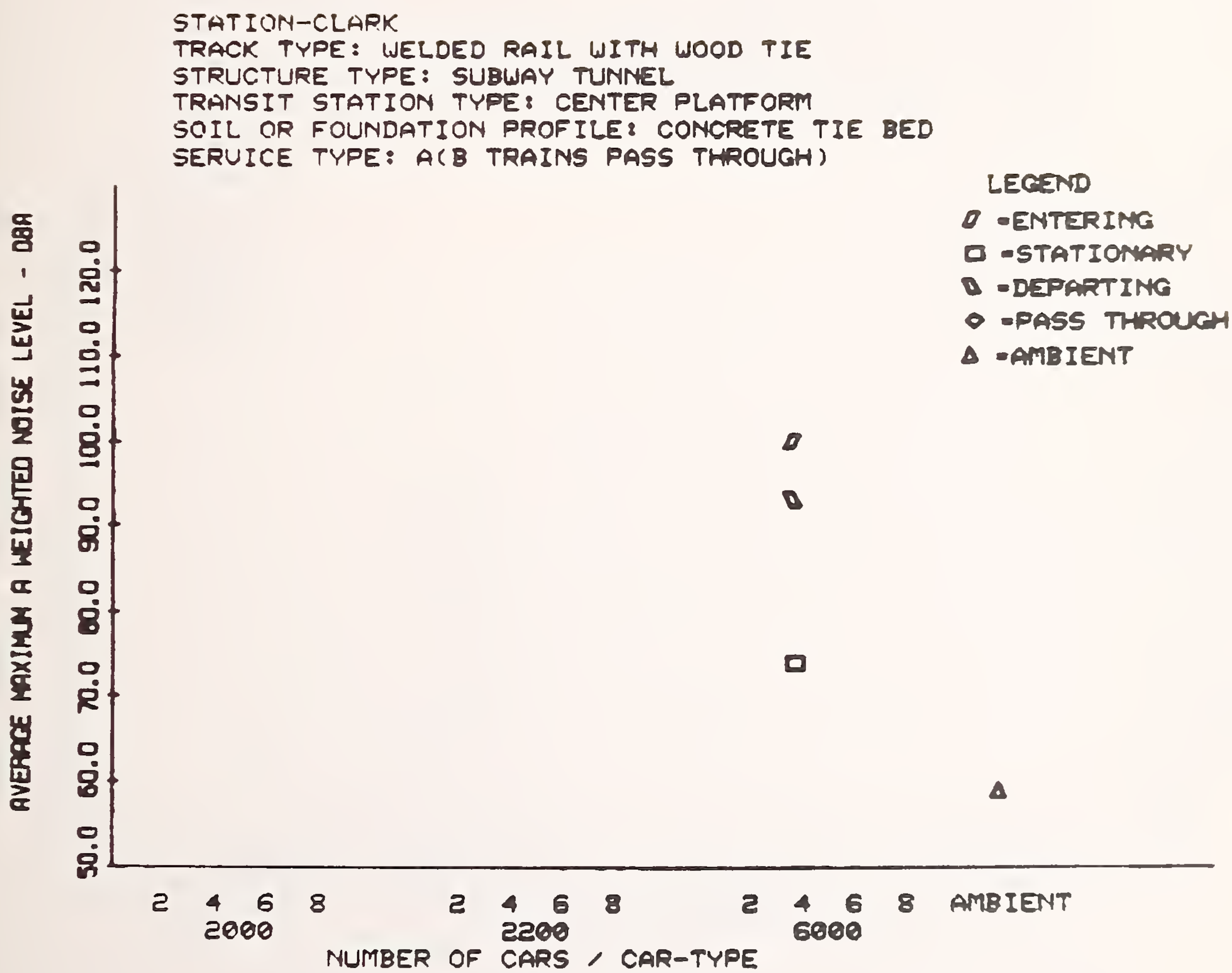
APPENDIX E

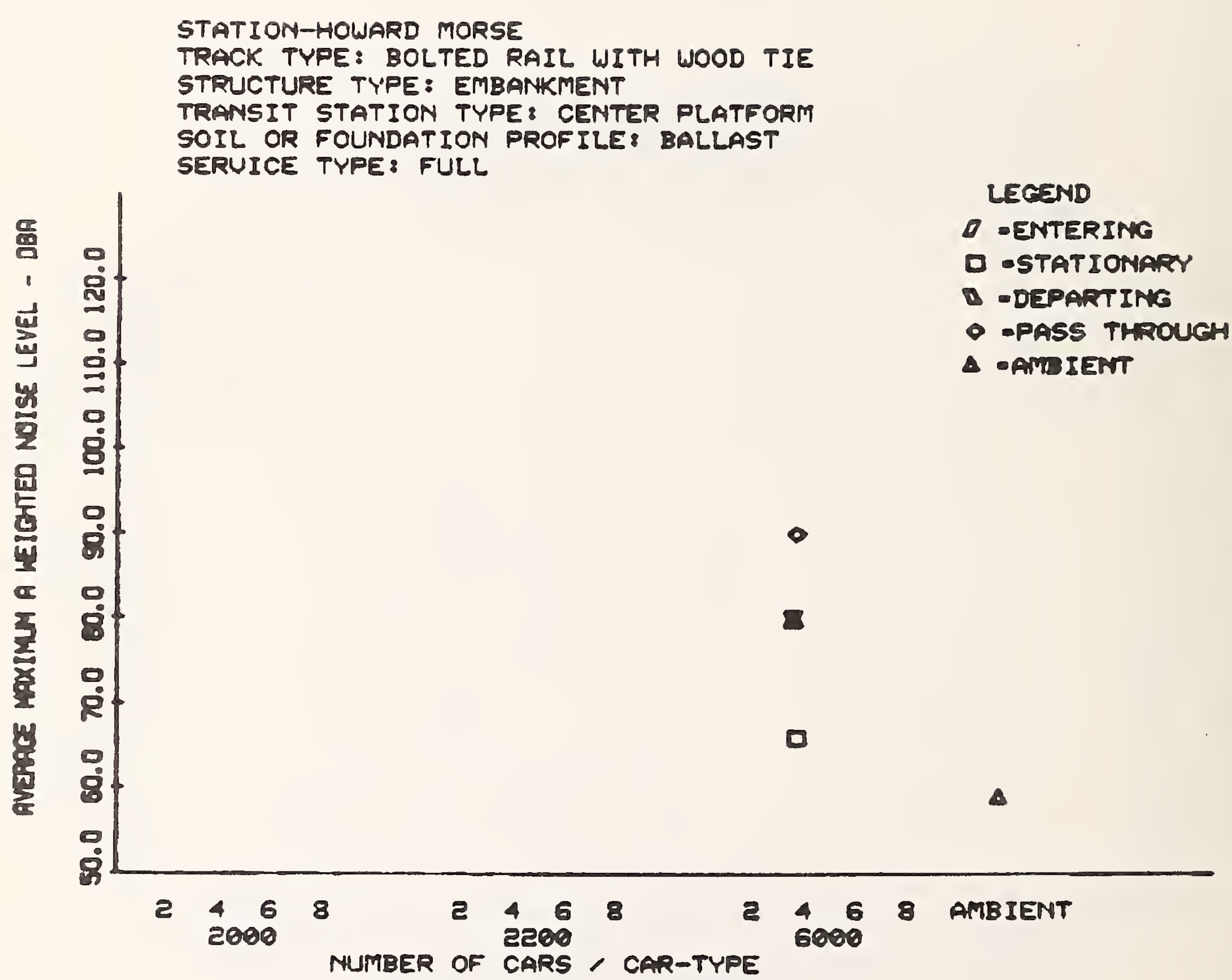
IN-STATION NOISE LEVELS VERSUS CAR TYPE



STATION-CHIAGO
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: FULL

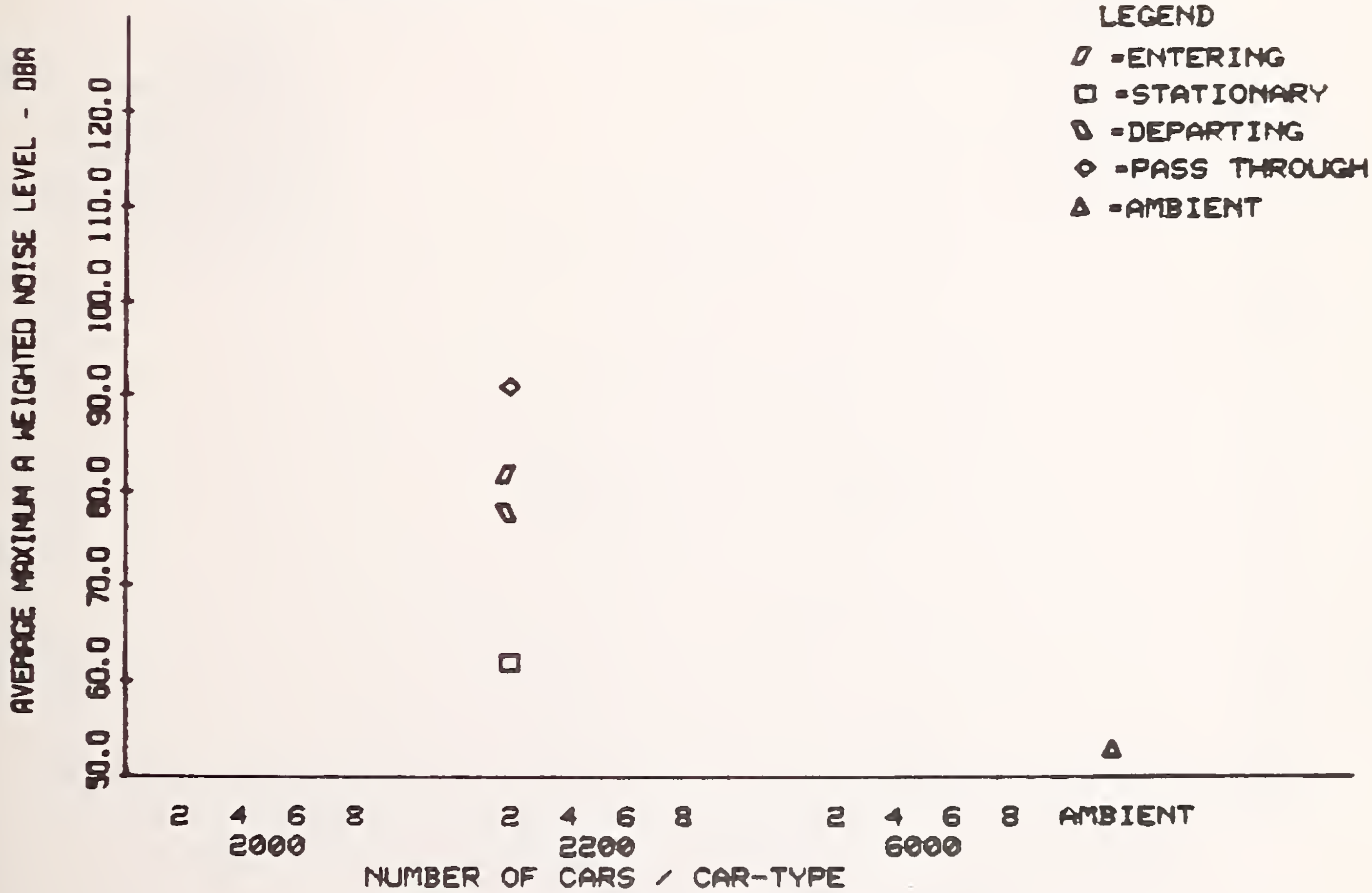



STATION-CLARK
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: A(B TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE

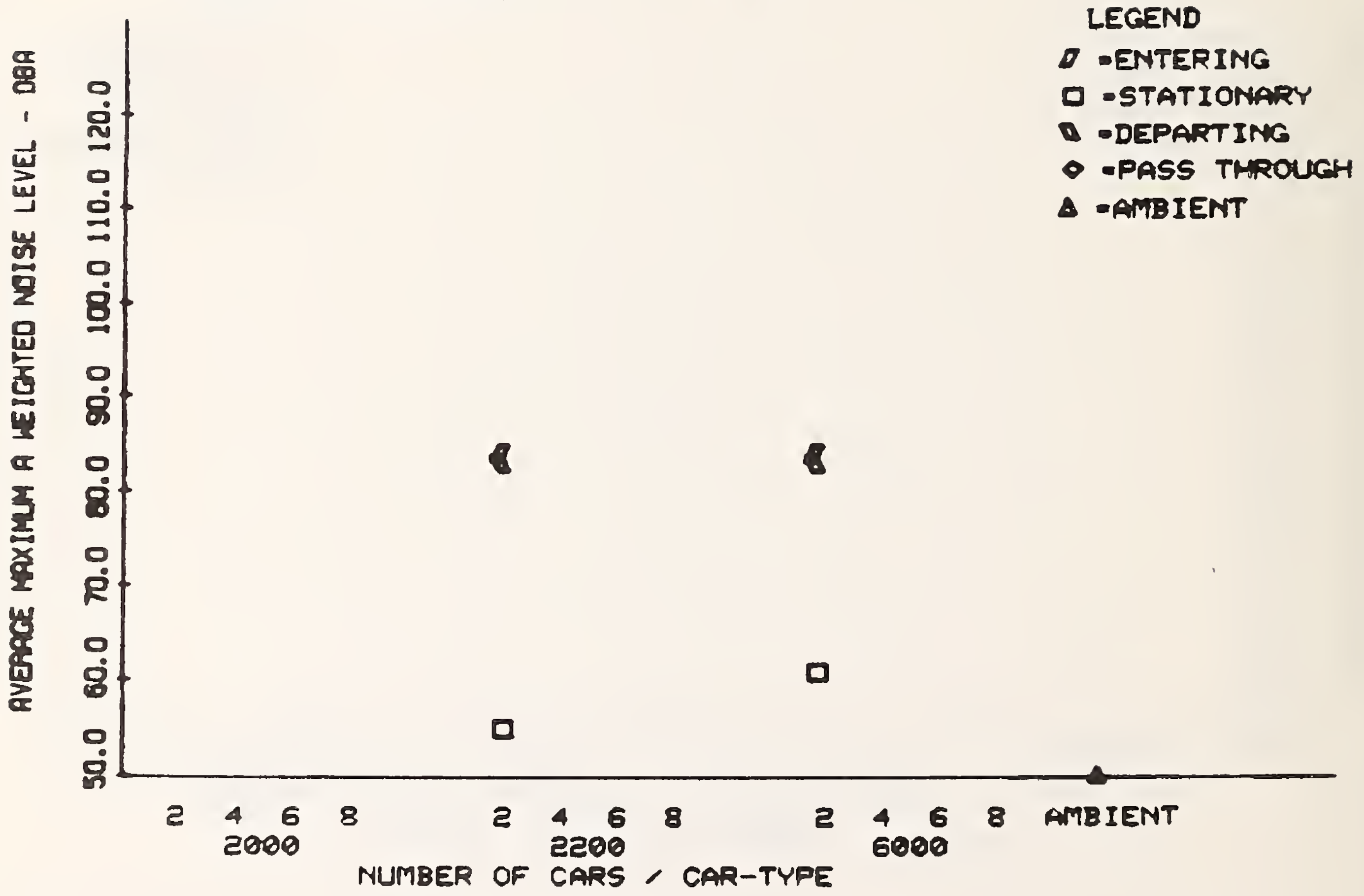


STATION-HOWARD MORSE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE

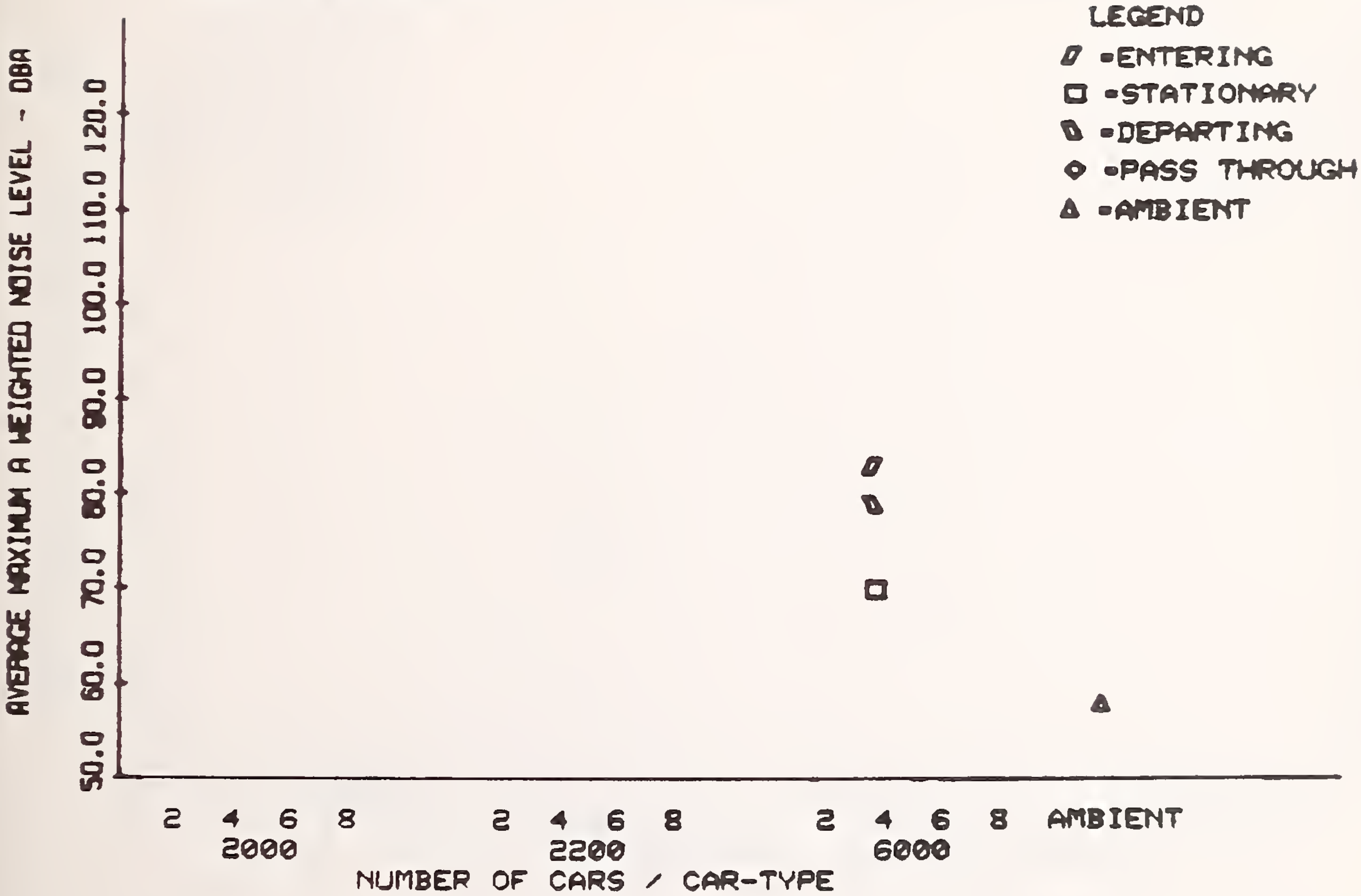
STATION-BELMOMT
TRACK TYPE: WELDED RAIL WITH CONCRETE TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: B(A TRAINS PASS THROUGH)

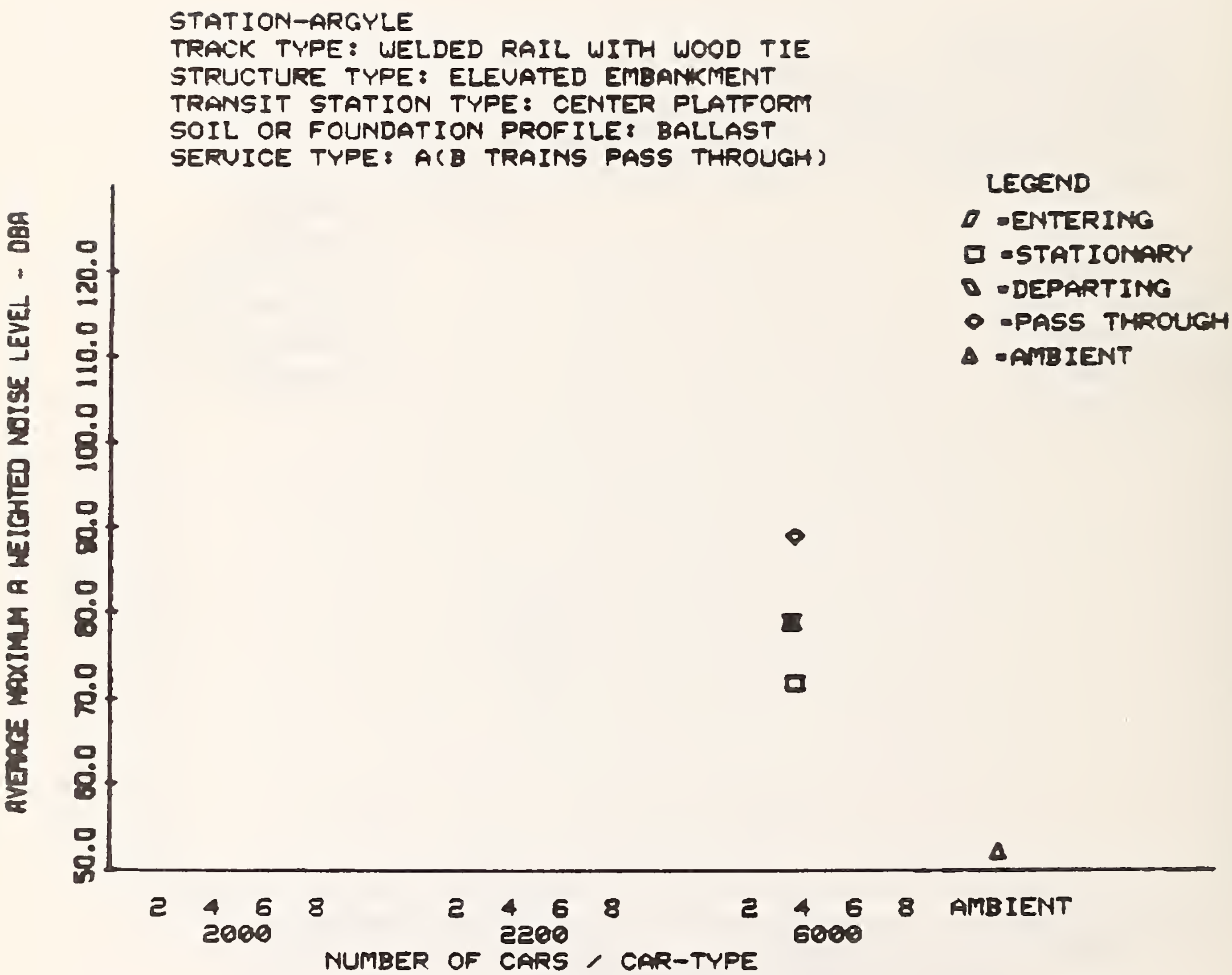


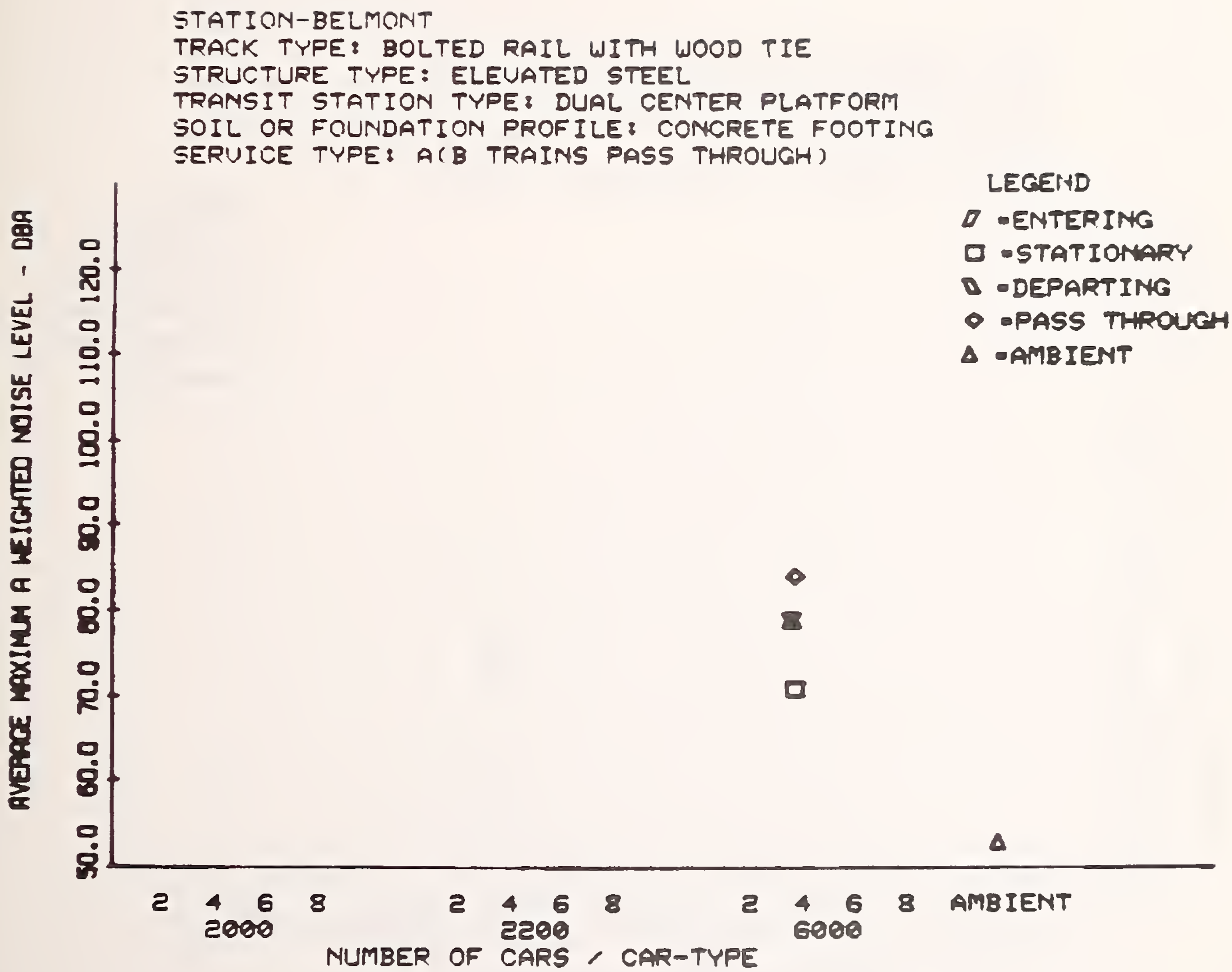
STATION-CLINTON
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

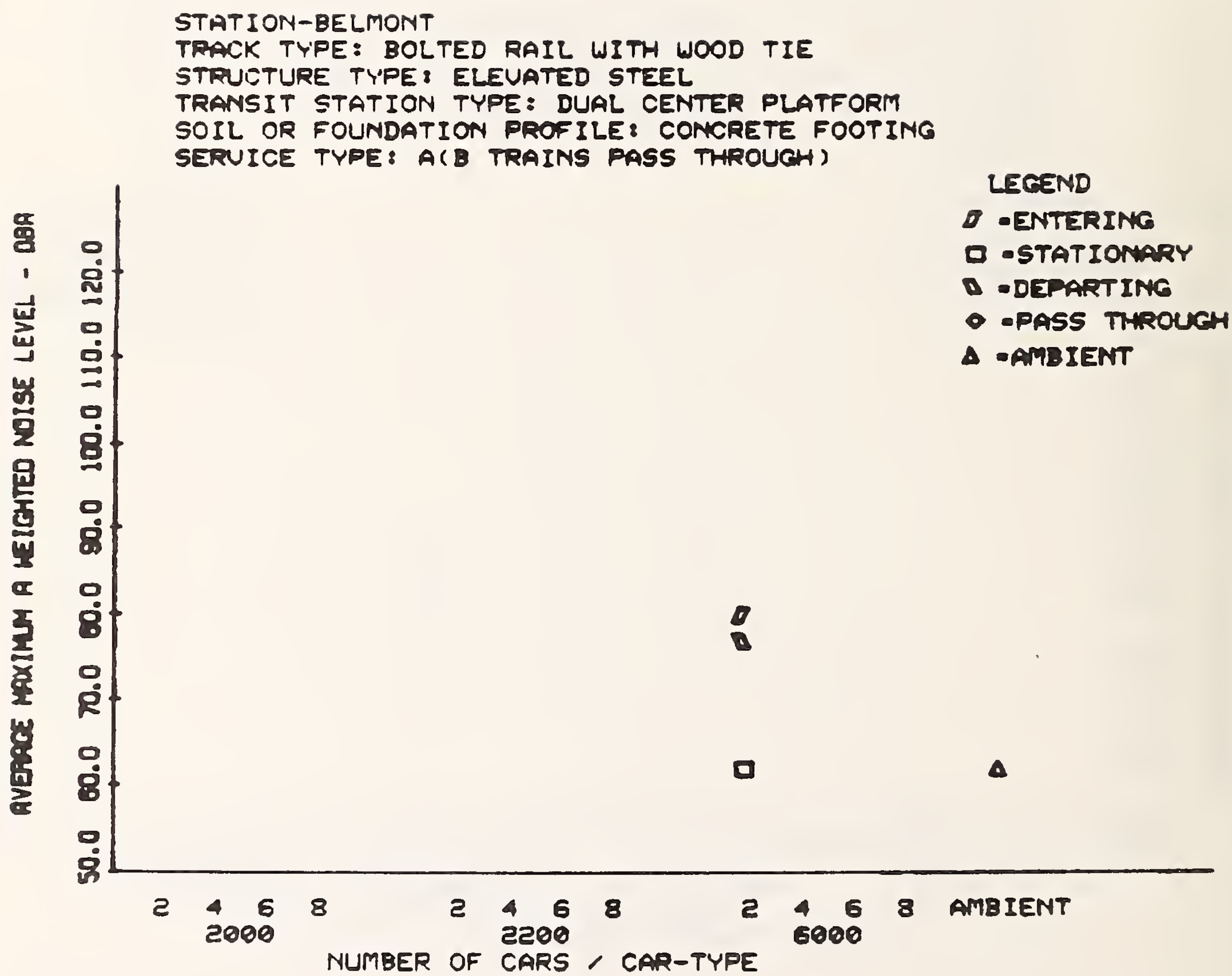


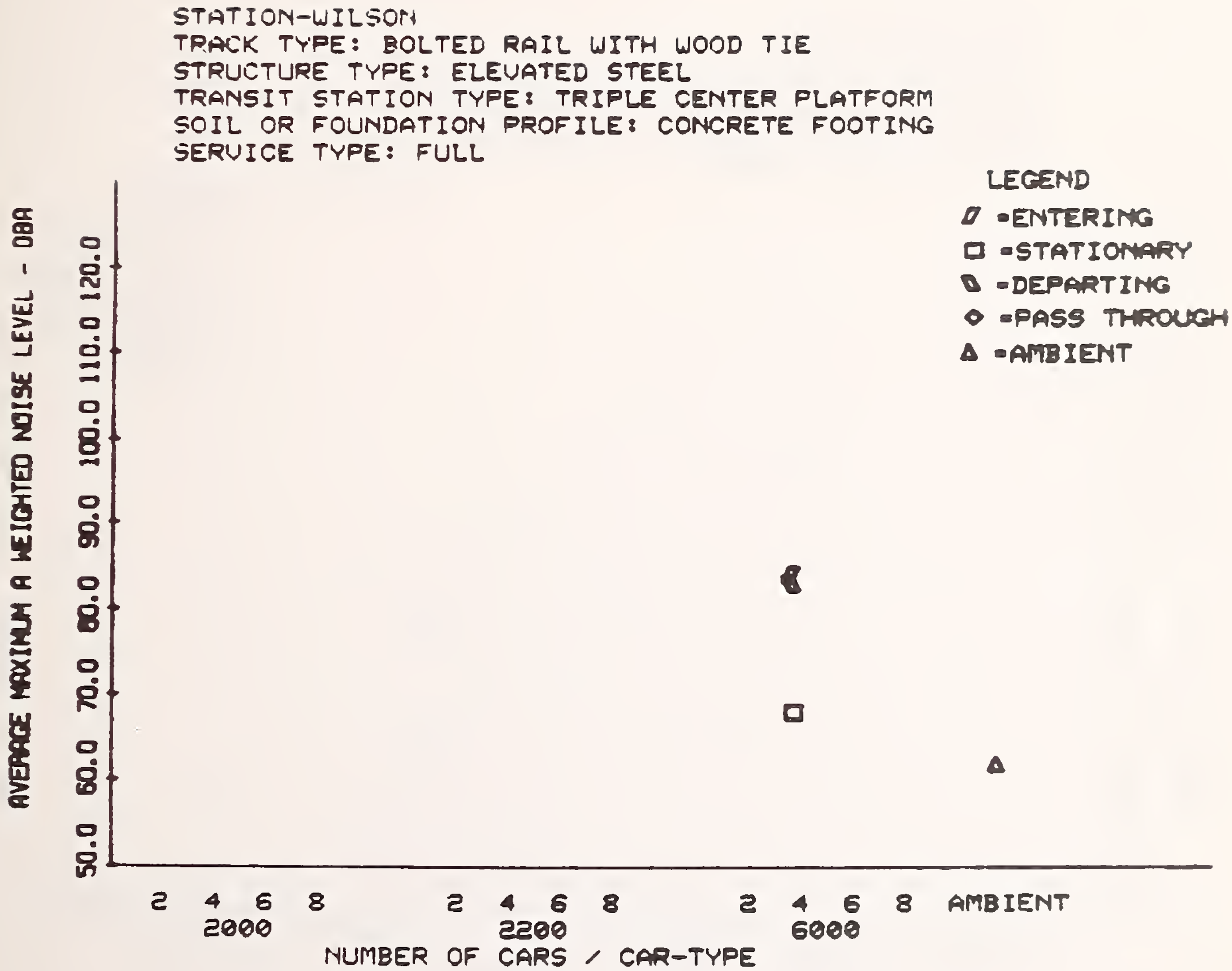
STATION-MORSE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

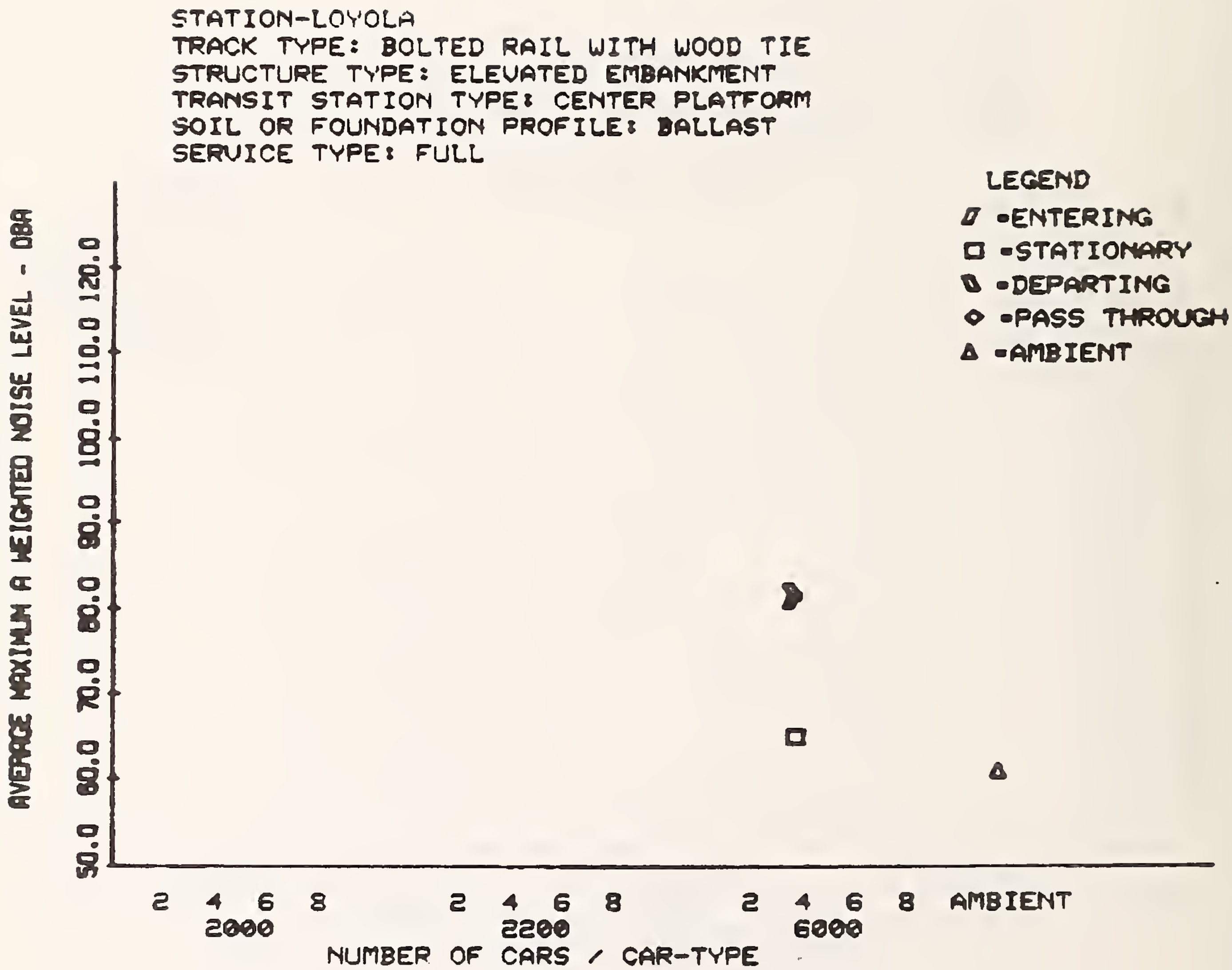



STATION-ARGYLE
TRACK TYPE: WELDED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: A(B TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0 60.0 70.0 80.0 90.0 100.0 110.0 120.0
2 4 6 8 2 4 6 8 2 4 6 8 AMBIENT
2000 2200 6000
NUMBER OF CARS / CAR-TYPE

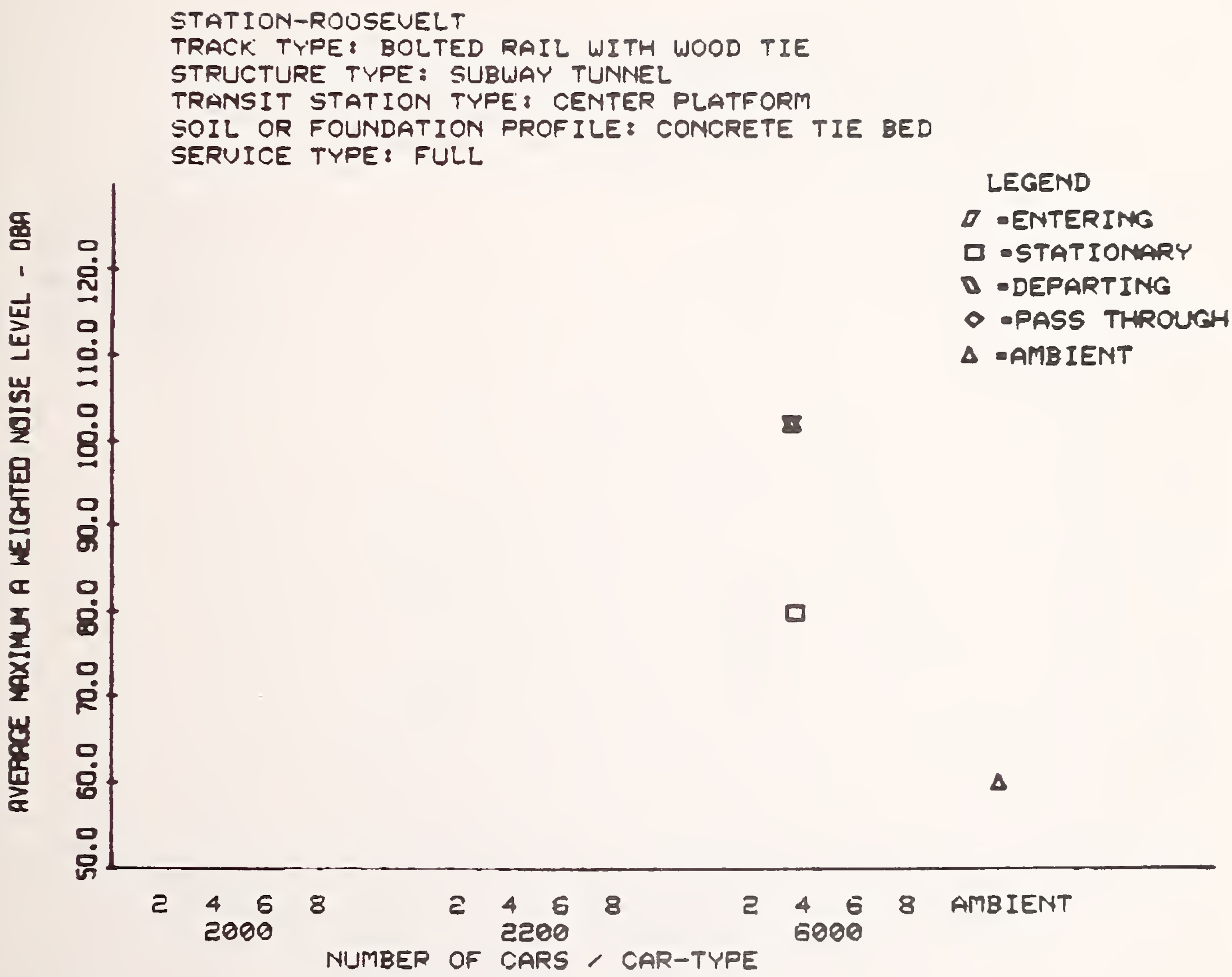

STATION-BELMONT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED STEEL
TRANSIT STATION TYPE: DUAL CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: A(B TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE

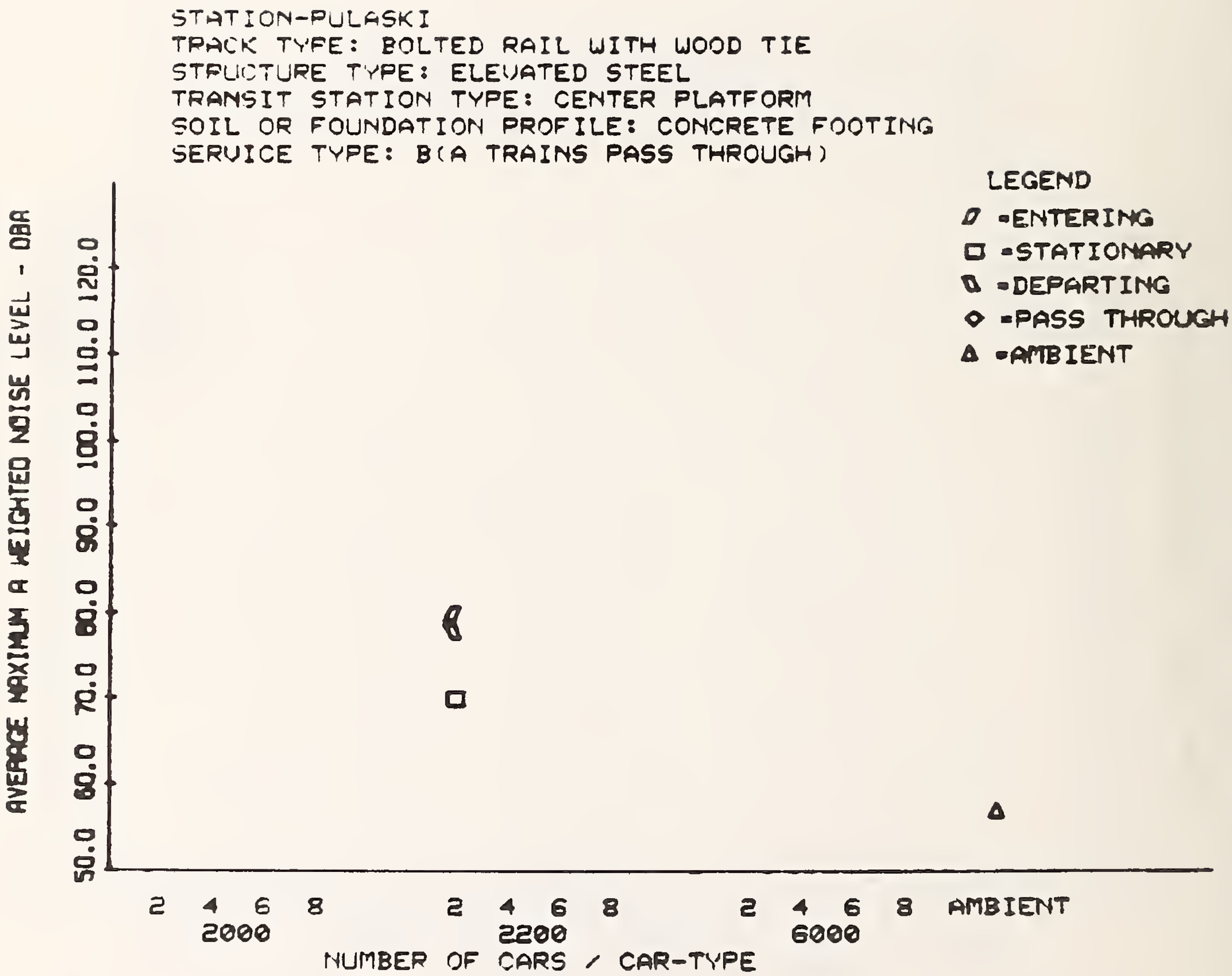

STATION-BELMONT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED STEEL
TRANSIT STATION TYPE: DUAL CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: A(B TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE

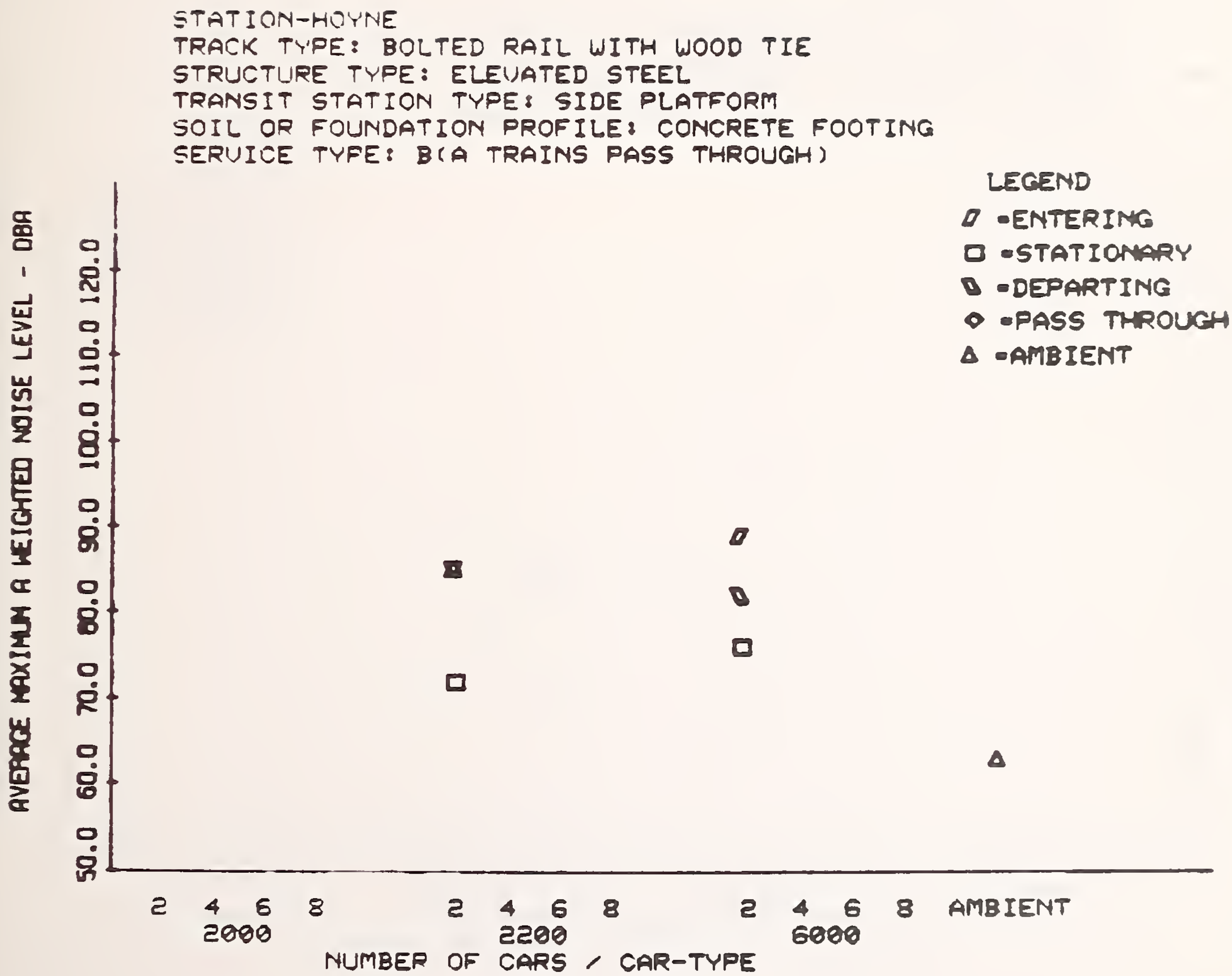

STATION-WILSON
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED STEEL
TRANSIT STATION TYPE: TRIPLE CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: FULL
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0 60.0 70.0 80.0 90.0 100.0 110.0 120.0
2 4 6 8 2 4 6 8 2 4 6 8 AMBIENT
2000 2200 6000
NUMBER OF CARS / CAR-TYPE

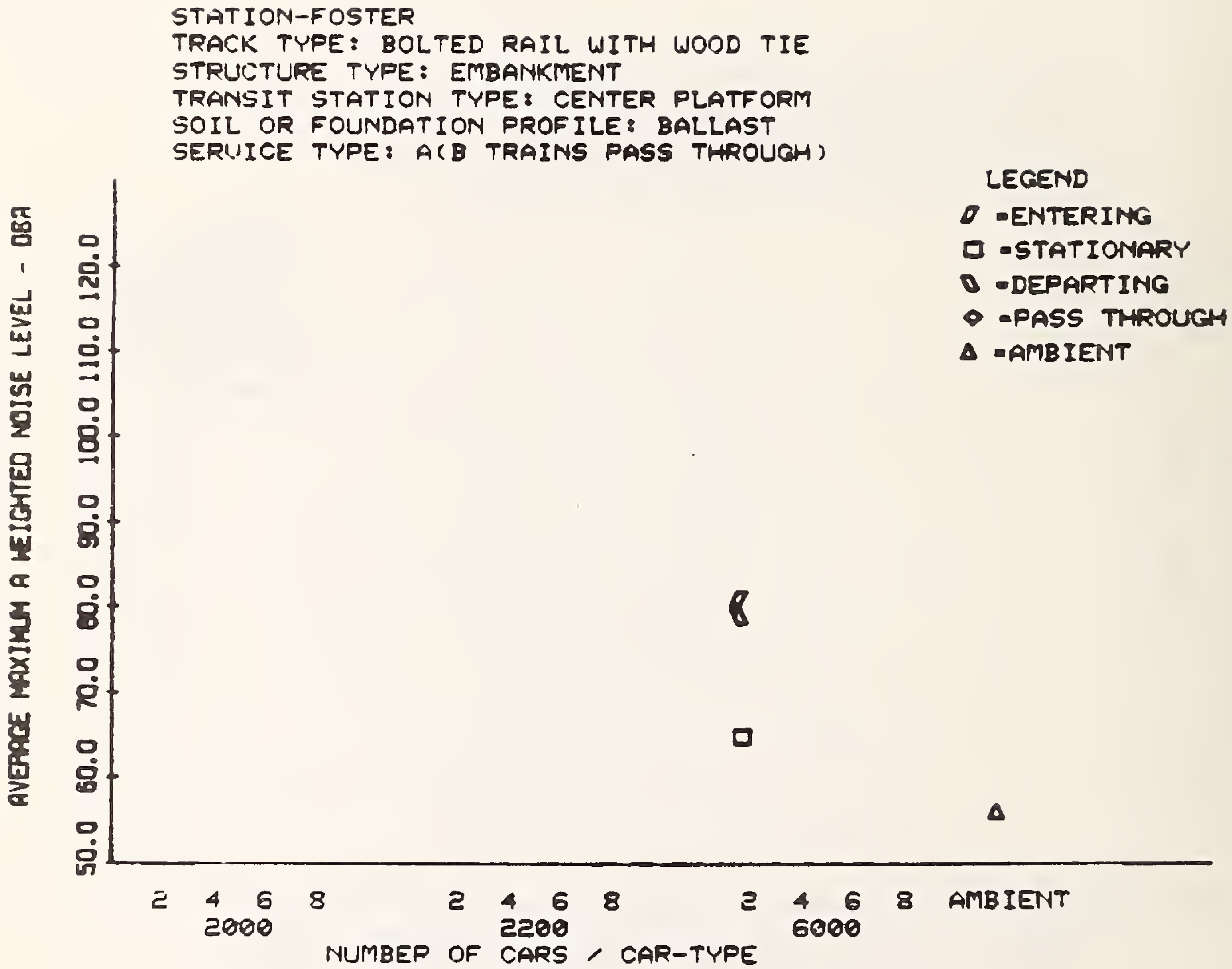


STATION-LOYOLA
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE

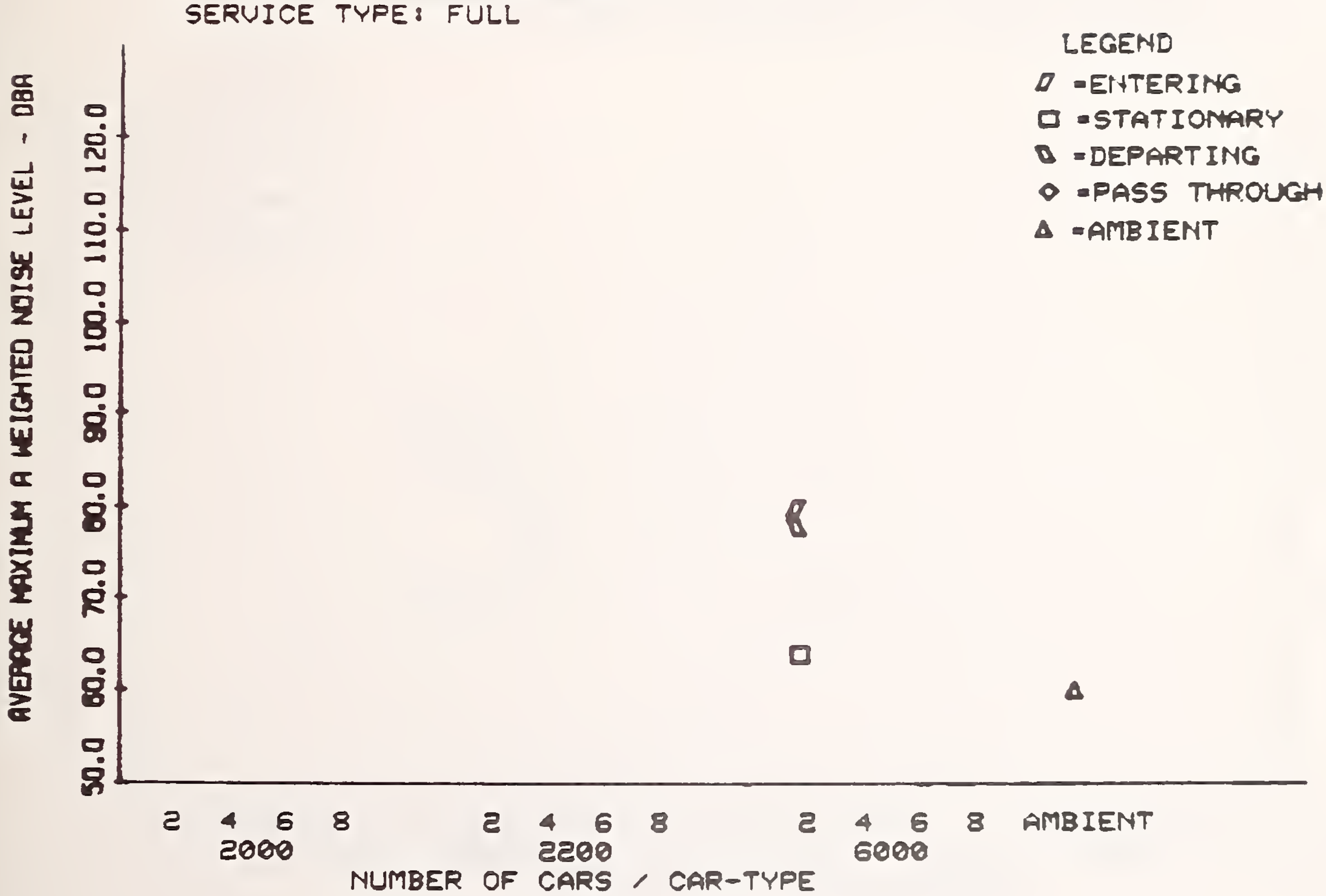

STATION-ROOSEVELT
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: SUBWAY TUNNEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE TIE BED
SERVICE TYPE: FULL
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0 60.0 70.0 80.0 90.0 100.0 110.0 120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE


STATION-PULASKI
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED STEEL
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: B(A TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
2 4 6 8
2000
2 4 6 8
2200
2 4 6 8
6000
AMBIENT
NUMBER OF CARS / CAR-TYPE

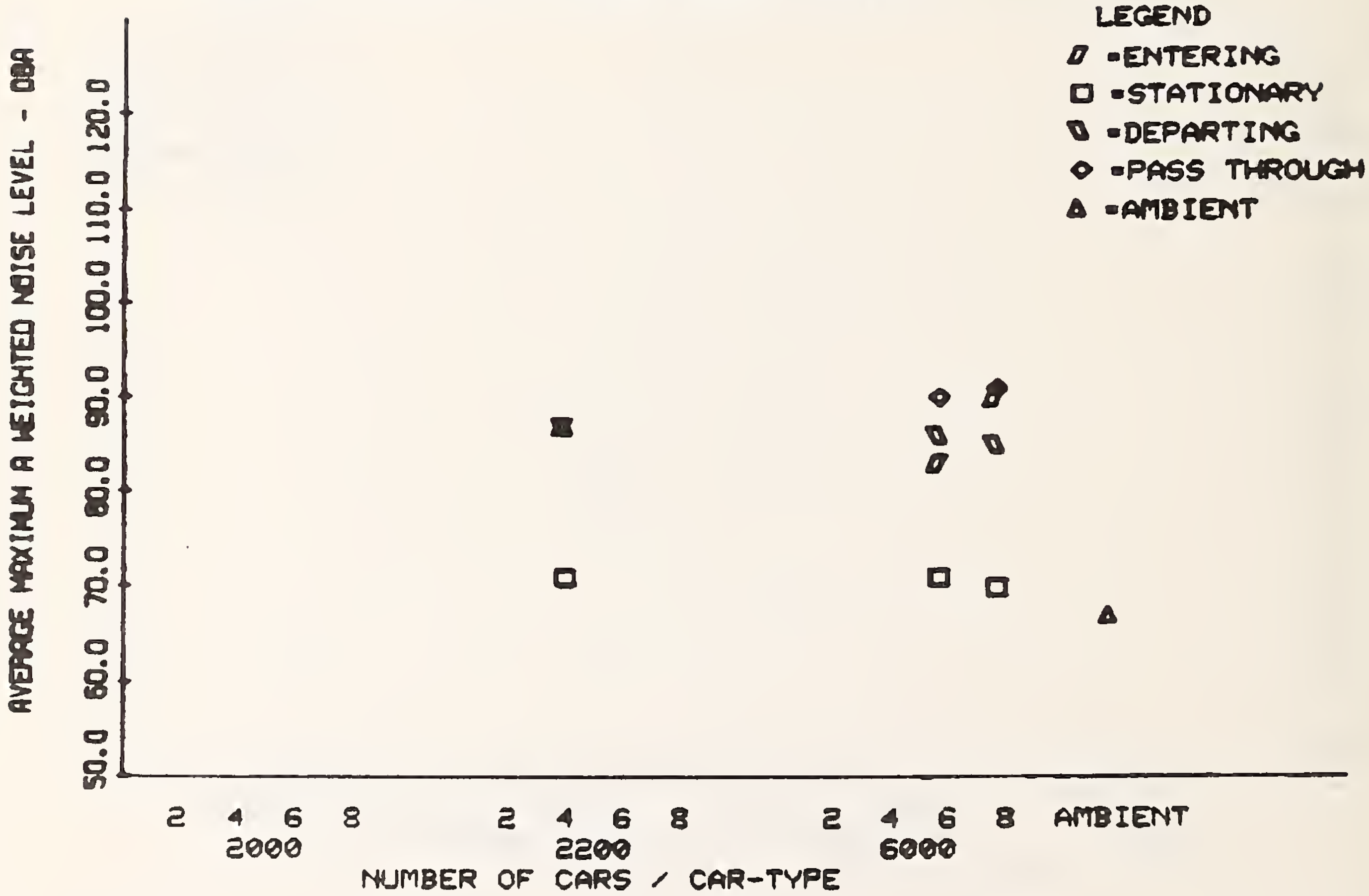

STATION-HOYNE
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED STEEL
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
SERVICE TYPE: B(A TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0 60.0 70.0 80.0 90.0 100.0 110.0 120.0
2 4 6 8 2 4 6 8 2 4 6 8 AMBIENT
2000 2200 6000
NUMBER OF CARS / CAR-TYPE


STATION-FOSTER
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: A(B TRAINS PASS THROUGH)
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
=AMBIENT
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0 60.0 70.0 80.0 90.0 100.0 110.0 120.0
2 4 6 8 2 4 6 8 2 4 6 8 AMBIENT
2000 2200 6000
NUMBER OF CARS / CAR-TYPE

STATION-DAVIS
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: EMBANKMENT
TRANSIT STATION TYPE: SIDE PLATFORM
SOIL OR FOUNDATION PROFILE: BALLAST
SERVICE TYPE: FULL

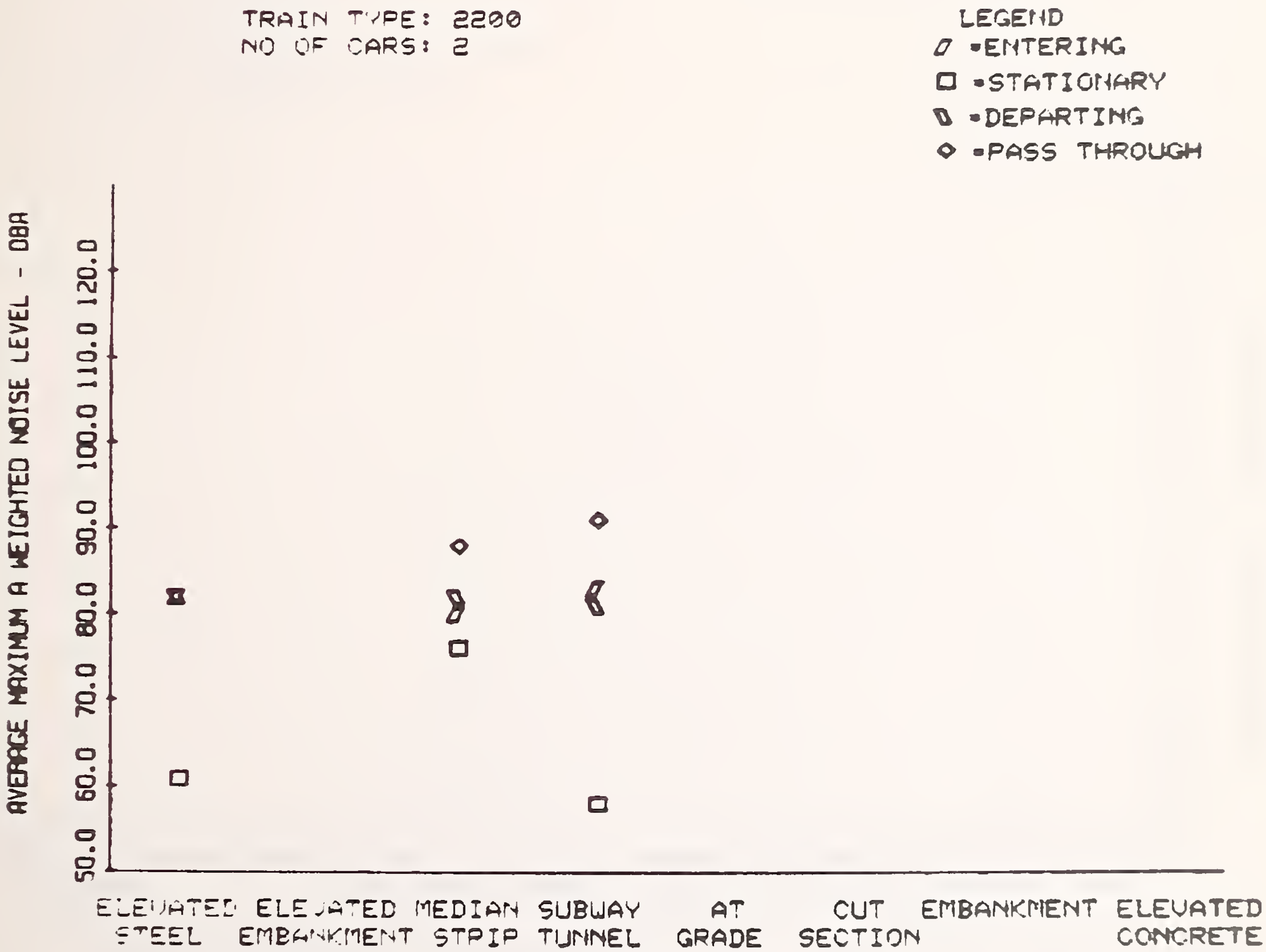


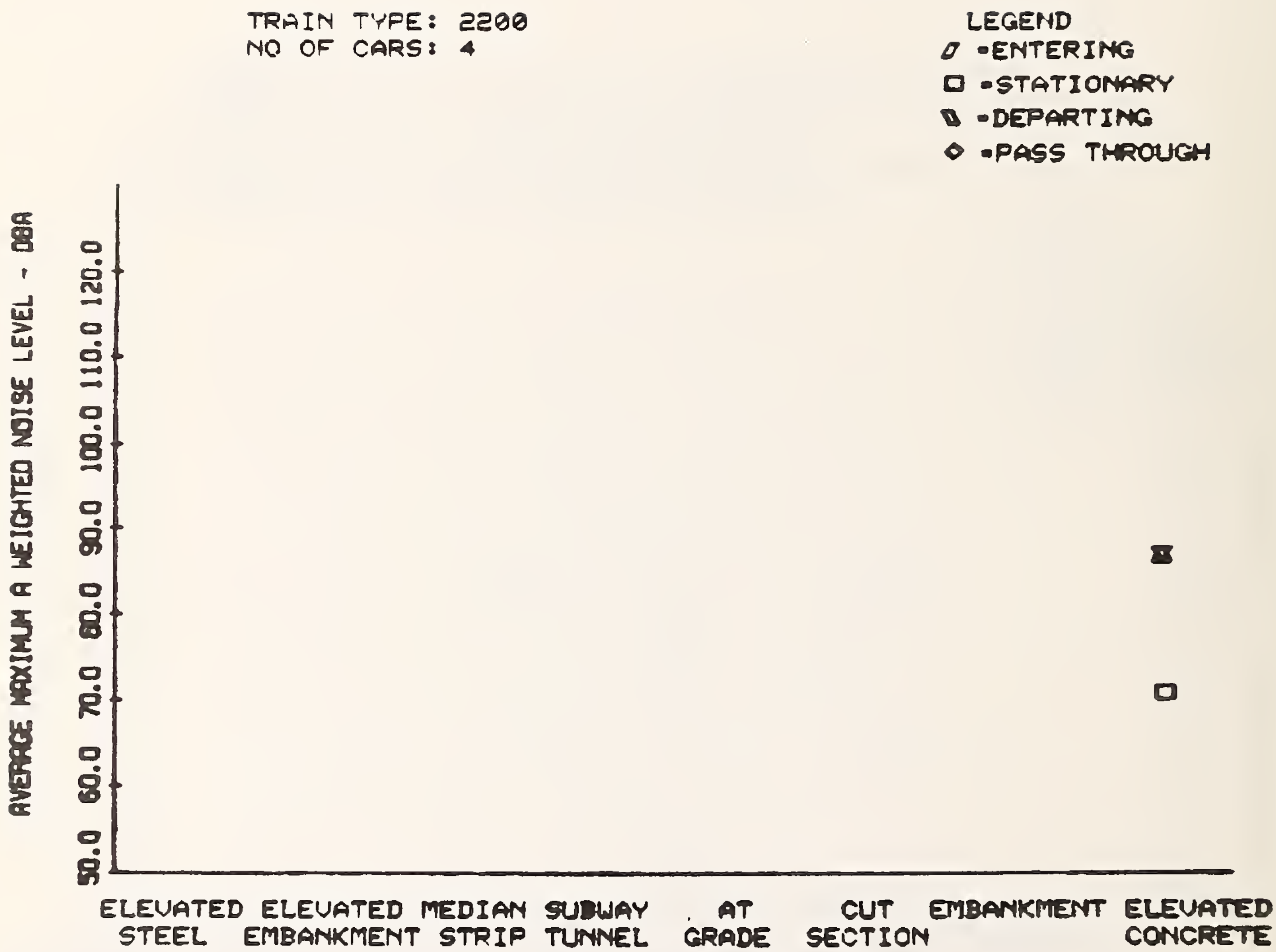
STATION-CERMAK
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
STRUCTURE TYPE: ELEVATED CONCRETE
TRANSIT STATION TYPE: CENTER PLATFORM
SOIL OR FOUNDATION PROFILE: ELEVATED CONCRETE, BALLAST
SERVICE TYPE: B(A TRAINS PASS THROUGH)

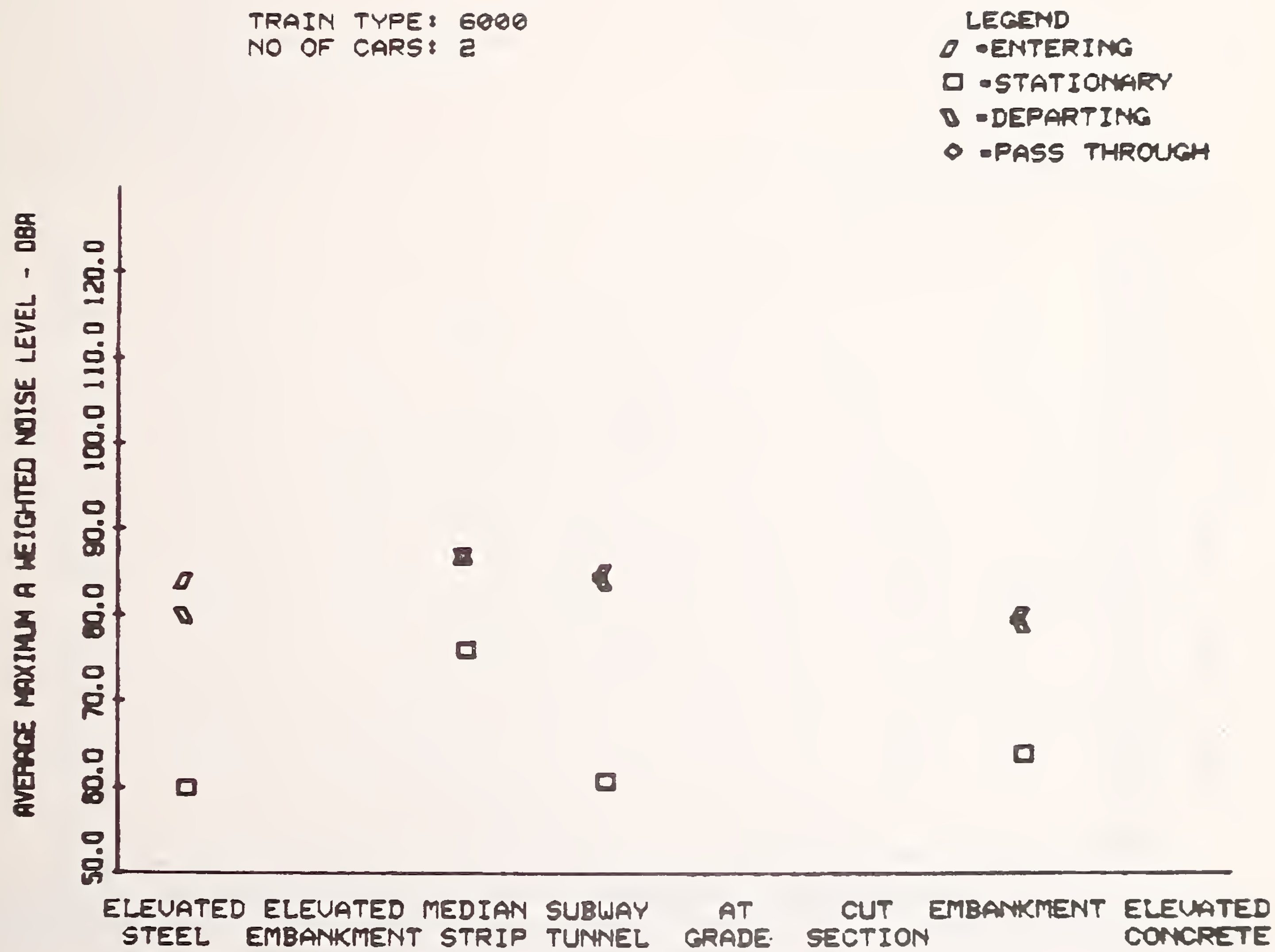


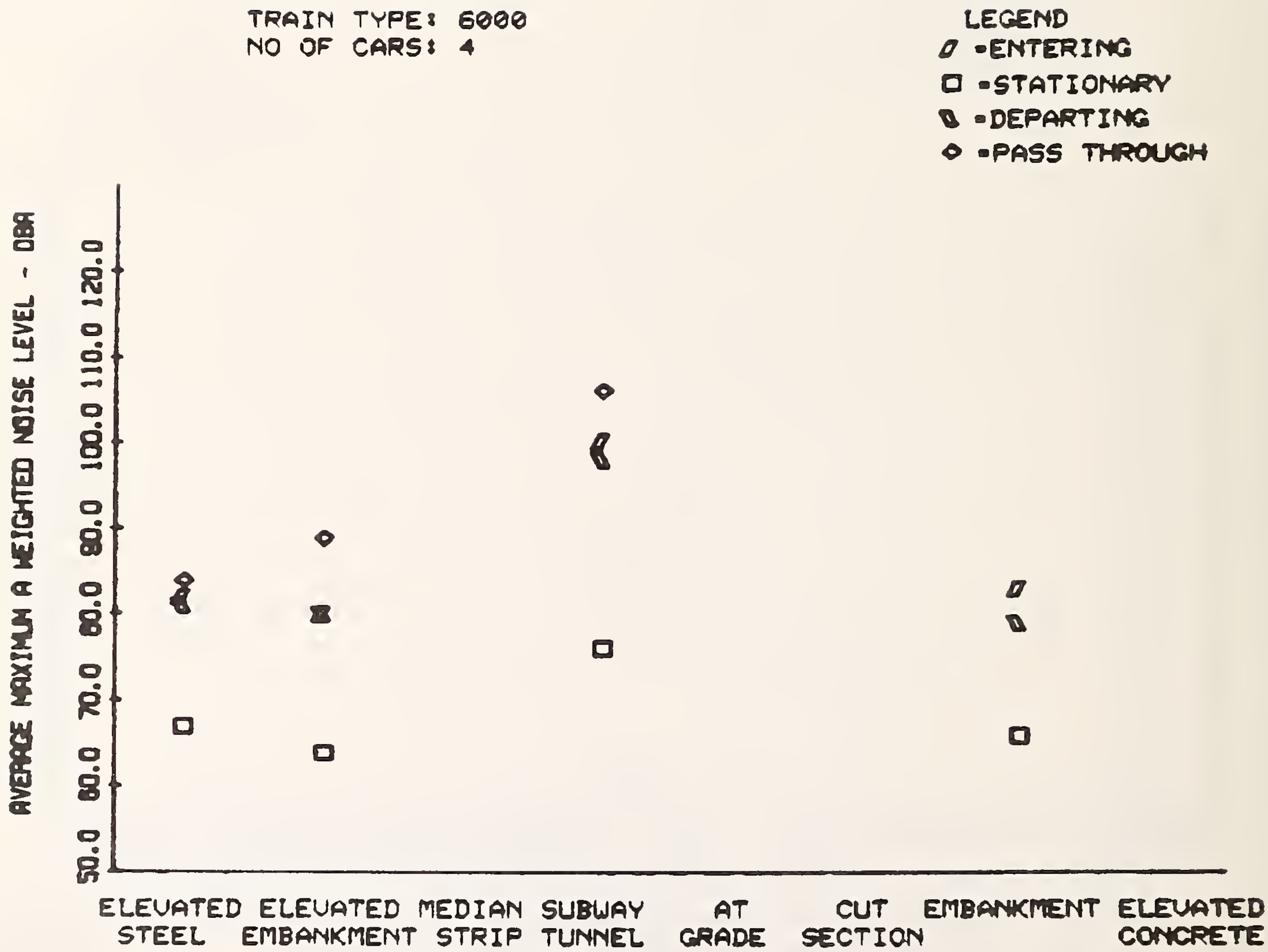
APPENDIX F

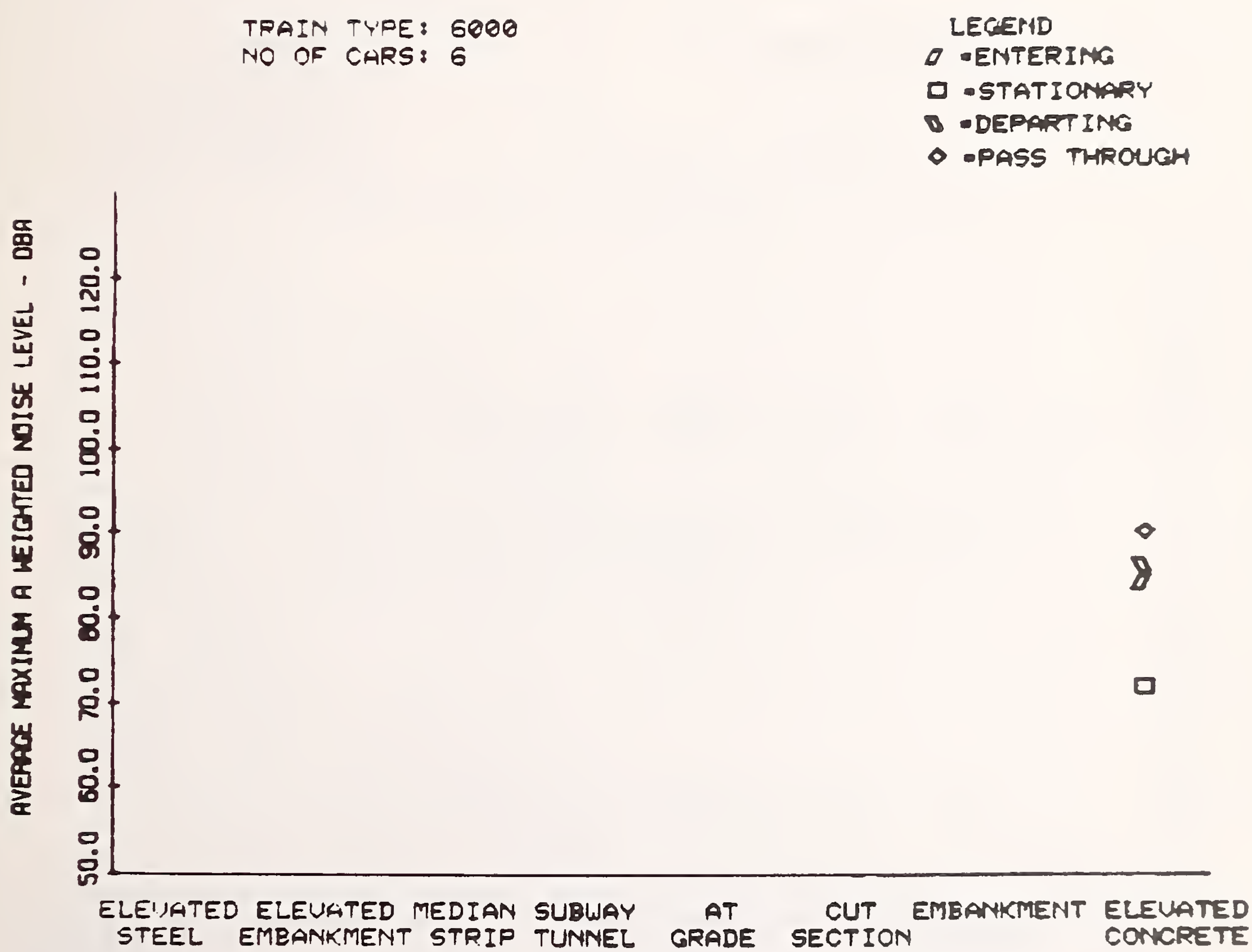
IN-STATION NOISE LEVELS VERSUS STRUCTURE TYPE



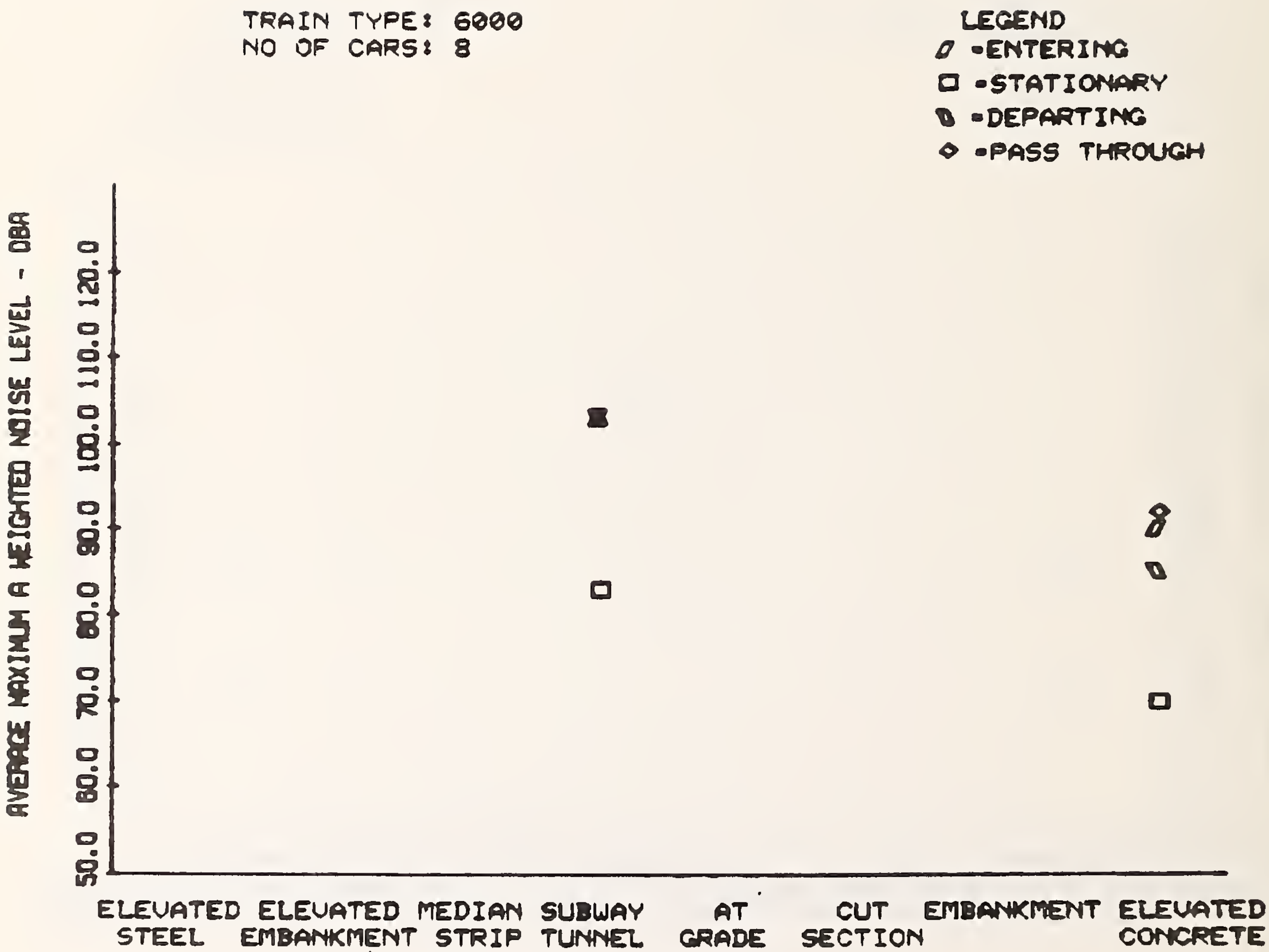

TRAIN TYPE: 2200
NO OF CARS: 4
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
ELEVATED STEEL
ELEVATED EMBANKMENT
MEDIAN STRIP
SUBWAY TUNNEL
AT GRADE
CUT SECTION
EMBANKMENT
ELEVATED CONCRETE


TRAIN TYPE: 6000
NO OF CARS: 2
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
ELEVATED STEEL
ELEVATED EMBANKMENT
MEDIAN STRIP
SUBWAY TUNNEL
AT GRADE
CUT SECTION
EMBANKMENT
ELEVATED CONCRETE


TRAIN TYPE: 6000
NO OF CARS: 4
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
ELEVATED STEEL
ELEVATED EMBANKMENT
MEDIAN STRIP
SUBWAY TUNNEL
AT GRADE
CUT SECTION
EMBANKMENT
ELEVATED CONCRETE



TRAIN TYPE: 6000
NO OF CARS: 6
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
ELEVATED STEEL
ELEVATED EMBANKMENT
MEDIAN STRIP
SUBWAY TUNNEL
AT GRADE
CUT SECTION
EMBANKMENT
ELEVATED CONCRETE



TRAIN TYPE: 6000
NO OF CARS: 8
LEGEND
=ENTERING
=STATIONARY
=DEPARTING
=PASS THROUGH
AVERAGE MAXIMUM A WEIGHTED NOISE LEVEL - DBA
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
ELEVATED STEEL
ELEVATED EMBANKMENT
MEDIAN STRIP
SUBWAY TUNNEL
AT GRADE
CUT SECTION
EMBANKMENT
ELEVATED CONCRETE

APPENDIX G

WAYSIDE NOISE MEASUREMENT DATA

FOR CTA LOCATION SK 19850 TO SK 19940
THE MAP LOCATION IS SK06 (SKOKIE BLVD UNDERPAS).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: UNDERPASS
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: ELEVATED CONCRETE
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
SK 19940-SK 19850 AT 11: 1 ON DEC 10, 1974
1 CAR INBOUND TRAIN NUMBER 6228, SPEED=30 MPH, COOL AND OVERCAST
CAR PATRON DENSITY: VERY LIGHT
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 68 DBA
DBA CURVE ON TAPE 3 IS TRIANGULAR, OVERPASS
MAX. PEAK = 82 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 82 DBA WITH DURATION(-5 DBA) = 3.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
PASSENGER NOISE
NOISE PATH(S):
BUILDING-WALL REVERBERATION
DIRECT FIELD
IN - CAR NOISE MEASUREMENT FOR
SK 19940-SK 19850 AT 12:20 ON DEC 10, 1974
1 CAR INBOUND TRAIN NUMBER 6228, SPEED=35 MPH, COOL AND OVERCAST
CAR PATRON DENSITY: VERY LIGHT
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 65 DBA
DBA CURVE ON TAPE 3 IS TRIANGULAR, THROUGH UNDERPASS
MAX. PEAK = 83 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 83 DBA WITH DURATION(-5 DBA) = 2.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
WHEEL SQUEAL
PASSENGER NOISE
NOISE PATH(S):
BUILDING-WALL REVERBERATION
DIRECT FIELD
WAYSIDE NOISE MEASUREMENT FOR
SK 19900 AT 10: 0 ON AUG 27, 1975
2 CAR INBOUND TRAIN NUMBER 6277, SPEED=30 MPH, WARM
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -50 HOR. FT., -15 VERT. FT.
AMBIENT NOISE LEVEL IS 62 DBA
DBA CURVE ON TAPE 28 IS TRIANGULAR, PASSBY
MAX. PEAK = 88 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 88 DBA WITH DURATION(-5 DBA) = 7.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

FOR CTA LOCATION NML 21300 TO NML 21700
THE MAP LOCATION IS RAV39 (+ HOW 62/OAKDL - GRG).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: ELEVATED STEEL
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 4
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
NML 21700-NML 21300 AT 10:15 ON DEC 18, 1974
2 CAR INBOUND TRAIN NUMBER 6063, SPEED=30 MPH, COLD AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 60 DBA
DBA CURVE ON TAPE 010 IS SEMI-CIRCULAR, RS CURVE SC=87
MAX. PEAK = 84 DBA WITH 3 PEAKS WITHIN -5 DBA
PLATEAU = 83 DBA WITH DURATION(-5 DBA) = 26.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
NML 21500 AT 10: 0 ON AUG 19, 1975
2 CAR INBOUND TRAIN NUMBER 6485, SPEED=29 MPH, CLEAR AND HOT
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -15 HOR. FT., -15 VERT. FT.
AMBIENT NOISE LEVEL IS 63 DBA
DBA CURVE ON TAPE 23 IS TRIANGULAR, PASSBY
MAX. PEAK = 100 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 100 DBA WITH DURATION(-5 DBA) = 3.7 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

```
FOR CTA LOCATION RN  18518 TO RN  18800
THE MAP LOCATION IS RAVI1 (ROCKWELL - ABUTMENT ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: ELEVATED EMBANKMENT
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
RN  18800-RN  18518 AT 10: 3 ON  DEC 18, 1974
 2 CAR INBOUND TRAIN NUMBER 6063, SPEED=25 MPH,  COLD AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   61 DBA
DBA CURVE ON TAPE  010 IS SEMI-CIRCULAR,  FS SC=2-76
MAX. PEAK =  72 DBA WITH  2 PEAKS WITHIN -5 DBA
PLATEAU =  70 DBA WITH DURATION(-5 DBA) =  12.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
RN  18650 AT 14: 0 ON  AUG 19, 1975
 2 CAR INBOUND TRAIN NUMBER 6000, SPEED=25 MPH,  CLEAR AND WARM
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -15 HOR. FT.,   -6 VERT. FT.
AMBIENT NOISE LEVEL IS   49 DBA
DBA CURVE ON TAPE   23 IS TRIANGULAR,  PASSBY
MAX. PEAK =  88 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  88 DBA WITH DURATION(-5 DBA) =   2.6 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

FOR CTA LOCATION RN 20500 TO RN 20800
THE MAP LOCATION IS RAV7 (MANOR - CHICAGO RIVR).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: AT-GRADE
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
RN 20800-RN 20500 AT 10: 2 ON DEC 18, 1974
2 CAR INBOUND TRAIN NUMBER 6063, SPEED=25 MPH, COLD AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 67 DBA
DBA CURVE ON TAPE 010 IS SEMI-CIRCULAR, RS CURVE
MAX. PEAK = 78 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 71 DBA WITH DURATION(-5 DBA) = 7.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
RN 20650 AT 18:30 ON AUG 19, 1975
2 CAR INBOUND TRAIN NUMBER 6482, SPEED=25 MPH, CLEAR AND WINDY
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -15 HOR. FT., 5 VERT. FT.
AMBIENT NOISE LEVEL IS 51 DBA
DBA CURVE ON TAPE 24 IS TRIANGULAR, PASSBY
MAX. PEAK = 87 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 87 DBA WITH DURATION(-5 DBA) = 2.8 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

```
FOR CTA LOCATION RN  21700 TO RN  22800
THE MAP LOCATION IS RAV5  (KEDZIE - SACRAMENTO ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: AT-GRADE
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
RN  22800-RN  21700 AT 10: 1 ON  DEC 18, 1974
 2 CAR INBOUND TRAIN NUMBER 6063, SPEED=25 MPH,  COLD AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   60 DBA
DBA CURVE ON TAPE  010 IS SEMI-CIRCULAR,  FS BUMP=75
MAX. PEAK =  77 DBA WITH  2 PEAKS WITHIN -5 DBA
PLATEAU =  74 DBA WITH DURATION(-5 DBA) =  36.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
POWER PICK-UP
NOISE SOURCES VERY NOTICEABLE
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
RN  21900 AT 17: 0 ON  AUG 19, 1975
 2 CAR INBOUND TRAIN NUMBER 6762, SPEED=32 MPH,  CLEAR BUT HOT
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -15 HOR. FT.,    5 VERT. FT.
AMBIENT NOISE LEVEL IS   50 DBA
DBA CURVE ON TAPE   23 IS TRIANGULAR,  PASSBY
MAX. PEAK =  92 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  92 DBA WITH DURATION(-5 DBA) =   2.7 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

```
FOR CTA LOCATION RN  24100 TO RN  24400
THE MAP LOCATION IS RAV2  (CURVE NR KIMBL STAT.).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: COMMERCIAL AND BUSINESS
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: AT-GRADE
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: TIGHT RADIUS, SLOW SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
RN  24400-RN  24100 AT 10: 0 ON  DEC 18, 1974
 2 CAR INBOUND TRAIN NUMBER 6063, SPEED=15 MPH,  COLD AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,     7 VERT. FT.
AMBIENT NOISE LEVEL IS   60 DBA
DBA CURVE ON TAPE  010 IS SEMI-CIRCULAR,  RS SC=77
MAX. PEAK =  74 DBA WITH  2 PEAKS WITHIN -5 DBA
PLATEAU =  73 DBA WITH DURATION(-5 DBA) =   7.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
RN  24250 AT  9: 0 ON  AUG 19, 1975
 2 CAR INBOUND TRAIN NUMBER 6073, SPEED=10 MPH,  CLEAR AND WINDY
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -15 HOR. FT.,     5 VERT. FT.
AMBIENT NOISE LEVEL IS   60 DBA
DBA CURVE ON TAPE   24 IS TRIANGULAR,  PASSBY
MAX. PEAK = 103 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU = 103 DBA WITH DURATION(-5 DBA) =   6.2 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

FOR CTA LOCATION M 9315 TO M 9915
THE MAP LOCATION IS MIL21 (PORTAL - CUT).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: CUT SECTION
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: EXCELLENT
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
MK 09915-MK 09315 AT 10:35 ON DEC 17, 1974
2 CAR OUTBOUND TRAIN NUMBER 6063, SPEED=28 MPH, WARM AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 59 DBA
DBA CURVE ON TAPE 006 IS SEMI-CIRCULAR, FS PORTAL-CUT
MAX. PEAK = 78 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 75 DBA WITH DURATION(-5 DBA) = 13.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
POWER PICK-UP
AIR CONDITIONING NOISE
PASSENGER NOISE
NOISE SOURCES VERY NOTICEABLE
RAIL JOINT
NOISE PATH(S):
BUILDING-WALL REVERBERATION
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
M 9600 AT 14: 0 ON AUG 28, 1975
4 CAR INBOUND TRAIN NUMBER 2235, SPEED=39 MPH, CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -50 HOR. FT., 0 VERT. FT.
AMBIENT NOISE LEVEL IS 58 DBA
DBA CURVE ON TAPE 27 IS TRIANGULAR, PASSBY
MAX. PEAK = 92 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 92 DBA WITH DURATION(-5 DBA) = 5.3 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

FOR CTA LOCATION LK 33425 TO LK 34400
THE MAP LOCATION IS LAK11 (LONG - LARAMIE STRS).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: MANUFACTURING
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: ELEVATED EMBANKMENT
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: WELDED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
LK 34400-LK 33425 AT 10:35 ON DEC 18, 1974
2 CAR INBOUND TRAIN NUMBER 2000, SPEED=30 MPH, COLD AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 63 DBA
DBA CURVE ON TAPE 009 IS SEMI-CIRCULAR, RS CRVE SC=86
MAX. PEAK = 82 DBA WITH 2 PEAKS WITHIN -5 DBA
PLATEAU = 77 DBA WITH DURATION(-5 DBA) = 10.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
POWER PICK-UP
PASSENGER NOISE
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
LK 33900 AT 13: 0 ON AUG 19, 1975
4 CAR INBOUND TRAIN NUMBER 2028, SPEED=40 MPH, HUMID AND HOT
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -50 HOR. FT., -15 VERT. FT.
AMBIENT NOISE LEVEL IS 63 DBA
DBA CURVE ON TAPE 23 IS TRIANGULAR, PASSBY
MAX. PEAK = 78 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 78 DBA WITH DURATION(-5 DBA) = 7.2 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

FOR CTA LOCATION NML 51100 TO NML 52300
THE MAP LOCATION IS HOW27 (SHERWIN - ESTES STRS).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: ELEVATED EMBANKMENT
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 4
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
NML 52300-NML 51100 AT 11:31 ON DEC 10, 1974
4 CAR INBOUND TRAIN NUMBER 6C12, SPEED=34 MPH, COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 65 DBA
DBA CURVE ON TAPE 0C4 IS SEMI-CIRCULAR, FULL SPEED SECTION
MAX. PEAK = 84 DBA WITH 3 PEAKS WITHIN -5 DBA
PLATEAU = 82 DBA WITH DURATION(-5 DBA) = 30.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
PASSENGER NOISE
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
NML 51700 AT 10: 0 ON AUG 30, 1975
4 CAR INBOUND TRAIN NUMBER 6001, SPEED=27 MPH, WET
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -15 HOR. FT., -6 VERT. FT.
AMBIENT NOISE LEVEL IS 60 DBA
DBA CURVE ON TAPE 28 IS TRIANGULAR, PASSBY
MAX. PEAK = 81 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 81 DBA WITH DURATION(-5 DBA) = 6.4 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

```
FOR CTA LOCATION EV  5580C TO EV  56400
THE MAP LOCATION IS HOW22 (MULFORD - CHICAGO   ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: COMMERCIAL AND BUSINESS
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: EMBANKMENT
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED. REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
EV  56400-EV  5580C AT 11: 8 ON  DEC 10, 1974
 1 CAR INBOUND TRAIN NUMBER 6023, SPEED=30 MPH,  COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   64 DBA
DBA CURVE ON TAPE    3 IS FLAT(RECTANGULAR),  FULL SPEED SECTION
MAX. PEAK =  88 DBA WITH  2 PEAKS WITHIN -5 DBA
PLATEAU =  85 DBA WITH DURATION(-5 DBA) =   5.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
PASSENGER NOISE
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
EV  56100 AT  9:30 ON  AUG 28, 1975
 2 CAR INBOUND TRAIN NUMBER 6683, SPEED=25 MPH,  HUMID BUT WARM
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -50 HOR. FT.,  -10 VERT. FT.
AMBIENT NOISE LEVEL IS   51 DBA
DBA CURVE ON TAPE   28 IS TRIANGULAR,  PASSBY
MAX. PEAK =  80 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  80 DBA WITH DURATION(-5 DBA) =   2.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

FOR CTA LOCATION EV 56400 TO EV 57500
THE MAP LOCATION IS HOW21 (SOUTH BLVD - MULFORD).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: COMMERCIAL AND BUSINESS
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: EMBANKMENT
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
EV 57500-EV 56400 AT 11: 8 ON DEC 10, 1974
1 CAR INBOUND TRAIN NUMBER 6023, SPEED=40 MPH, COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 64 DBA
DBA CURVE ON TAPE 3 IS FLAT(RECTANGULAR), FULL SPEED SECTION
MAX. PEAK = 88 DBA WITH 2 PEAKS WITHIN -5 DBA
PLATEAU = 85 DBA WITH DURATION(-5 DBA) = 25.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
PASSENGER NOISE
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
EV 56900 AT 11: 0 ON AUG 30, 1975
2 CAR INBOUND TRAIN NUMBER 6013, SPEED=25 MPH, HUMID
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -50 HOR. FT., -10 VERT. FT.
AMBIENT NOISE LEVEL IS 56 DBA
DBA CURVE ON TAPE 28 IS TRIANGULAR, PASSBY
MAX. PEAK = 76 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 75 DBA WITH DURATION(-5 DBA) = 2.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

```
FOR CTA LOCATION DR  52816 TO DR  53600
THE MAP LOCATION IS DAN71 (RI. RR. CURVE        ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: COMMERCIAL AND BUSINESS
WAYSIDE DISTANCE: GREATER THAN 25M (75 FT.)
STRUCTURE TYPE: ELEVATED CONCRETE
SOIL OR FOUNDATION PROFILE: ELEVATED CONCRETE, BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: EXCELLENT
TRACK GEOMETRY: TIGHT RADIUS, SLOW SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
DR  53600-DR  52815 AT 11:14 ON  DEC 18, 1974
 2 CAR OUTBOUND TRAIN NUMBER 2229, SPEED=20 MPH,  COLD AND CLOUDY
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   62 DBA
DBA CURVE ON TAPE  008 IS SEMI-CIRCULAR,  TGT RAD SC=87
MAX. PEAK =  85 DBA WITH  3 PEAKS WITHIN -5 DBA
PLATEAU =  82 DBA WITH DURATION(-5 DBA) =  12.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
POWER PICK-UP
AIR CONDITIONING NOISE
PASSENGER NOISE
NOISE SOURCES VERY NOTICEABLE
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
DR  53200 AT  8:30 ON  AUG 30, 1975
 2 CAR INBOUND TRAIN NUMBER 2243, SPEED=20 MPH,  COOL
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -15 HOR. FT.,  -50 VERT. FT.
AMBIENT NOISE LEVEL IS   72 DBA
DBA CURVE ON TAPE   28 IS TRIANGULAR,  PASSBY
MAX. PEAK =  89 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  89 DBA WITH DURATION(-5 DBA) =   6.8 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

FOR CTA LOCATION C 31220 TO C 31400
THE MAP LOCATION IS CON13 (CUT - PORTAL).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, LOW DENSITY
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: CUT SECTION
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
C 31400-C 31220 AT 10: 5 ON DEC 17, 1974
2 CAR INBOUND TRAIN NUMBER 6063, SPEED=40 MPH, WARM AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 67 DBA
DBA CURVE ON TAPE 006 IS SEMI-CIRCULAR, CUT PORTAL CURVE
MAX. PEAK = 86 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 84 DBA WITH DURATION(-5 DBA) = 4.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
POWER PICK-UP
AIR CONDITIONING NOISE
PASSENGER NOISE
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
BUILDING-WALL REVERBERATION
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
C 31300 AT 17: 0 ON AUG 28, 1975
2 CAR INBOUND TRAIN NUMBER 2292, SPEED=43 MPH, HOT
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -50 HOR. FT., 20 VERT. FT.
AMBIENT NOISE LEVEL IS 63 DBA
DBA CURVE ON TAPE 27 IS TRIANGULAR, PASSBY
MAX. PEAK = 80 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 80 DBA WITH DURATION(-5 DBA) = 1.9 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

```
FOR CTA LOCATION C   31400 TO C   32200
THE MAP LOCATION IS CON12 (CENTRAL AVE - CUT    ).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, LOW DENSITY
WAYSIDE DISTANCE: 7.5M (25 FT.) TO 25M (75 FT.)
STRUCTURE TYPE: AT-GRADE
SOIL OR FOUNDATION PROFILE: BALLAST
TRACK TYPE: WELDED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: GOOD
TRACK GEOMETRY: CURVED, REDUCED SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
C   32200-C   31400 AT 10: 5 ON  DEC 17, 1974
 2 CAR INBOUND TRAIN NUMBER 6063, SPEED=40 MPH,  WARM AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   67 DBA
DBA CURVE ON TAPE  006 IS SEMI-CIRCULAR,  CUT CURVE LOW SPEED
MAX. PEAK =  83 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  79 DBA WITH DURATION(-5 DBA) =  11.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
POWER PICK-UP
AIR CONDITIONING NOISE
PASSENGER NOISE
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
BUILDING-WALL REVERBERATION
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
C   31800 AT 13: 0 ON  AUG 21, 1975
 2 CAR INBOUND TRAIN NUMBER 2288, SPEED=45 MPH,  HOT
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -50 HOR. FT.,    5 VERT. FT.
AMBIENT NOISE LEVEL IS   65 DBA
DBA CURVE ON TAPE   26 IS TRIANGULAR,  PASSBY
MAX. PEAK =  87 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  87 DBA WITH DURATION(-5 DBA) =   2.2 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

```
FOR CTA LOCATION DP  18200 TO DP  19700
THE MAP LOCATION IS DPK28 (DAMEN ST. - WOOD ST.).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: ELEVATED STEEL
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: BELOW AVERAGE
TRACK GEOMETRY: STRAIGHT TANGENT, FULL SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
DP  19000-DP  18200 AT 11:24 ON  DEC 17, 1974
 2 CAR OUTBOUND TRAIN NUMBER 6C14, SPEED=20 MPH,  COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   62 DBA
DBA CURVE ON TAPE  007 IS FLAT(RECTANGULAR),  SLOW SPEED SECTION
MAX. PEAK =  88 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU =  88 DBA WITH DURATION(-5 DBA) =  25.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
IN - CAR NOISE MEASUREMENT FOR
DP  19700-DP  19000 AT 11:24 ON  DEC 17, 1974
 2 CAR OUTBOUND TRAIN NUMBER 6C14, SPEED=32 MPH,  COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:    0 HOR. FT.,    7 VERT. FT.
AMBIENT NOISE LEVEL IS   62 DBA
DBA CURVE ON TAPE  007 IS FLAT(RECTANGULAR),  FULL SPEED SECTION
MAX. PEAK =  92 DBA WITH  4 PEAKS WITHIN -5 DBA
PLATEAU =  88 DBA WITH DURATION(-5 DBA) =  25.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE  NOISE MEASUREMENT FOR
DP  19000 AT 10: 0 ON  AUG 18, 1975
 2 CAR INBOUND TRAIN NUMBER 6200, SPEED=33 MPH,  WARM AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER:  -15 HOR. FT.,  -15 VERT. FT.
AMBIENT NOISE LEVEL IS   70 DBA
DBA CURVE ON TAPE   23 IS TRIANGULAR,  PASSBY
MAX. PEAK = 106 DBA WITH  1 PEAKS WITHIN -5 DBA
PLATEAU = 106 DBA WITH DURATION(-5 DBA) =   2.5 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
```

FOR CTA LOCATION DP 17200 TO DP 18200
THE MAP LOCATION IS DPK29 (WOOD ST. - 19TH.ST.).
THE PHYSICAL ATTRIBUTES ARE:
WAYSIDE COMMUNITY TYPE: RESIDENTIAL, HIGH DENSITY
WAYSIDE DISTANCE: LESS THAN 7.5M (25 FT.)
STRUCTURE TYPE: ELEVATED STEEL
SOIL OR FOUNDATION PROFILE: CONCRETE FOOTING
TRACK TYPE: BOLTED RAIL WITH WOOD TIE
NUMBER OF TRACKS: 2
TRACK CONDITION: BELOW AVERAGE
TRACK GEOMETRY: TIGHT RADIUS, SLOW SPEED SECTION
IN - CAR NOISE MEASUREMENT FOR
DP 17600-DP 17200 AT 11:23 ON DEC 17, 1974
2 CAR OUTBOUND TRAIN NUMBER 6014, SPEED=30 MPH, COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 62 DBA
DBA CURVE ON TAPE 007 IS SEMI-CIRCULAR, FULL SPEED SECTION
MAX. PEAK = 88 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 82 DBA WITH DURATION(-5 DBA) = 20.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
IN - CAR NOISE MEASUREMENT FOR
DP 18200-DP 17600 AT 11:23 ON DEC 17, 1974
2 CAR OUTBOUND TRAIN NUMBER 6014, SPEED=10 MPH, COOL AND BRISK
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: 0 HOR. FT., 7 VERT. FT.
AMBIENT NOISE LEVEL IS 62 DBA
DBA CURVE ON TAPE 007 IS FLAT(RECTANGULAR), SLOW SPEED SECTION
MAX. PEAK = 80 DBA WITH 5 PEAKS WITHIN -5 DBA
PLATEAU = 73 DBA WITH DURATION(-5 DBA) = 25.0 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
POWER PICK-UP
NOISE SOURCES VERY NOTICEABLE
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE
WAYSIDE NOISE MEASUREMENT FOR
DP 17700 AT 15: 0 ON AUG 18, 1975
2 CAR INBOUND TRAIN NUMBER 6322, SPEED=11 MPH, WARM AND CLEAR
CAR PATRON DENSITY: MEDIUM, AS IN OFF-RUSH HOUR
MIC. DISTANCE FROM TRACK CENTER: -15 HOR. FT., -15 VERT. FT.
AMBIENT NOISE LEVEL IS 52 DBA
DBA CURVE ON TAPE 23 IS TRIANGULAR, PASSBY
MAX. PEAK = 92 DBA WITH 1 PEAKS WITHIN -5 DBA
PLATEAU = 92 DBA WITH DURATION(-5 DBA) = 4.9 SEC.
NOISE SOURCES PRESENT BUT NOT SIGNIFICANT
RAIL JOINT
WHEEL SQUEAL
NOISE PATH(S):
DIRECT FIELD
STRUCTURE BORNE

☆U.S. GOVERNMENT PRINTING OFFICE: 1979—600-699/297